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THE NEW GERMAN HIGHWAY SYSTEM

Interesting Differences from American Design and Construction Methods

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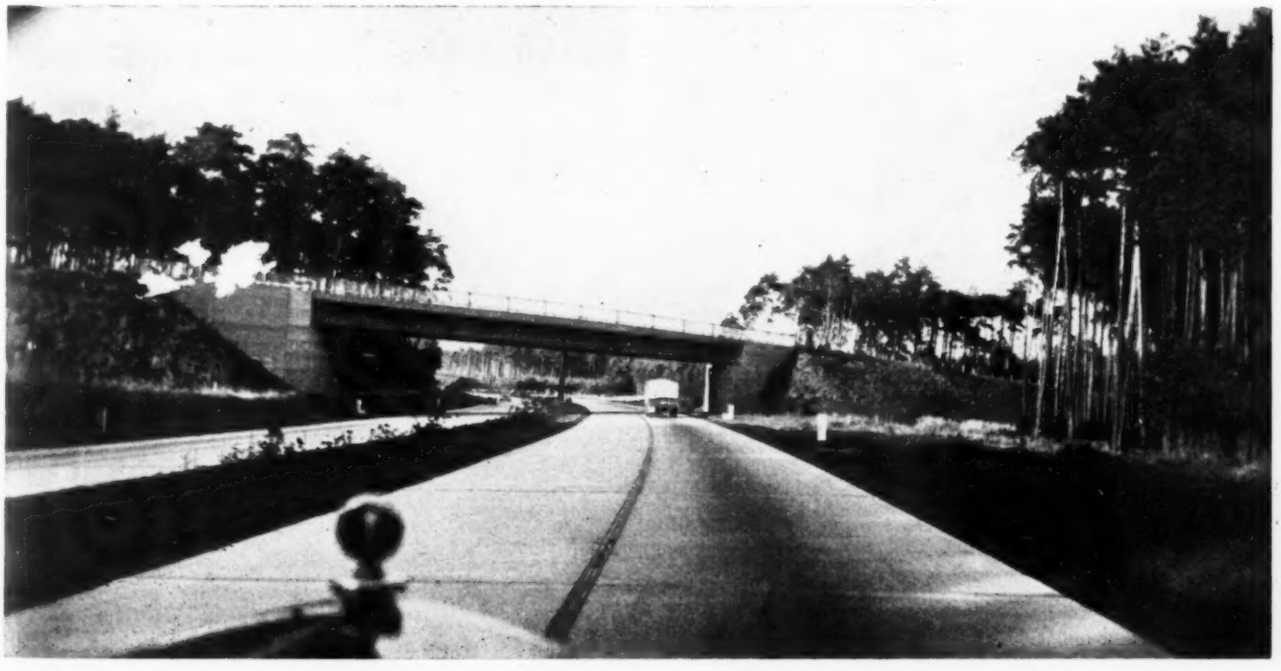
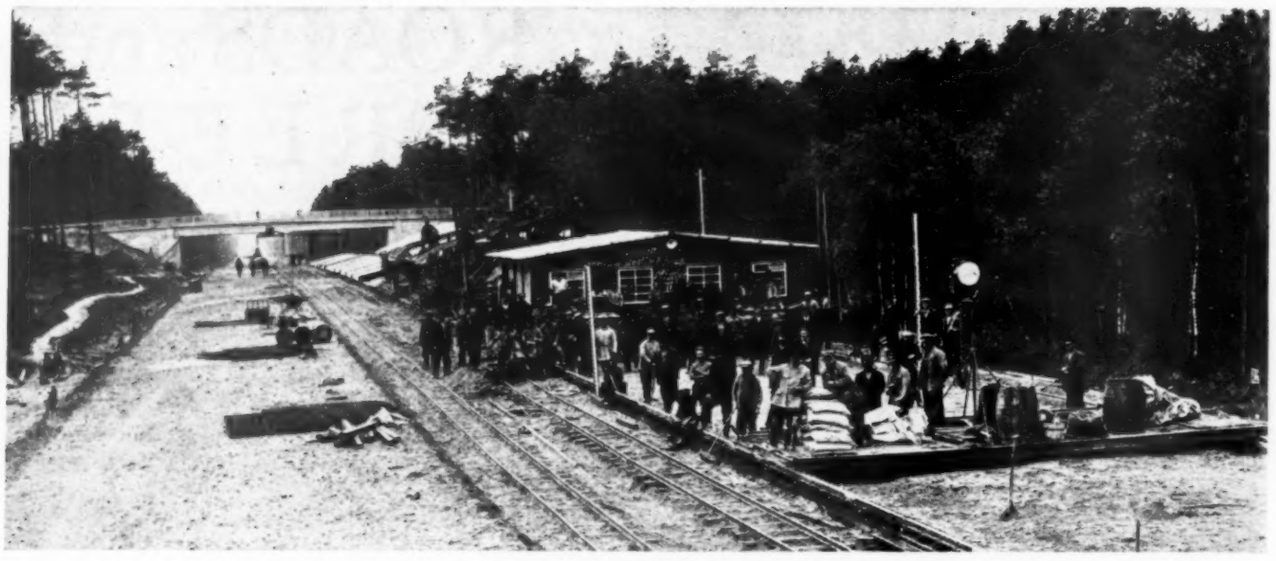
WHILE the design and methods of construction of the new German highway system is in many ways much like that used in this country, there are some very interesting differences. Many of these differences are necessary because of different problems to be met and others because development, both in equipment and materials may have followed along somewhat different lines.

Standard Design.—The standard design for this system of highways, which is to form a trunk line net work of about 4,300 miles when completed, is two separate slabs 24 ft. 6 in. wide with an open strip or parkway at least 16 ft. wide between them. For the most part the pavement will be a concrete slab, with a uniform thickness of about 8 in. This in most cases to be on a sand cushion. Along either edge of these slabs are strips of bituminous material about 1¾ in. thick on a 6 in. concrete base. The strip along the inside is about 18 in. wide and that along the outside about 3 ft. 4 in. These strips not only protect the shoulder but because of the contrast in color make the edge of the slab more easily seen for night driving.

The Location.—For the most part, the old roads follow along routes which have been in use for many years, in some cases hundreds, and which for many reasons would not fit into a modern highway system.



Section of Dual Highway Between Frankfort and Heidelberg.



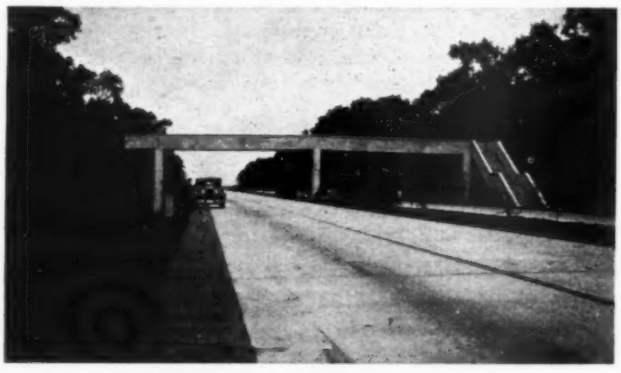
The Mixing and Placing as Well as the Finishing Equipment Is Carried on the Forms.

Even though it has been necessary to follow new routes and cut across good farmland and through good forests, in a country where both are of vital importance, there has been nothing spared as to the width of the right-of-way.

Overpasses and Bridges.—In no case, in the full 4,300 miles, will there be a crossing of any type of traffic at the same elevation. Special pedestrial overpasses are provided where there is considerable distance between regular overpasses. There are places where there are as many as eight or ten highway crossings in a mile. It is very common to see three at one time. These overpasses are of many types of construction and design and it is very seldom that adjacent ones are of the same type.

Most of the long bridges are of the continuous girder type in which one continuous girder extends from abutment to abutment, even though it may pass over several piers. The new bridge over the Main at Frankfort is of this type, one girder extending from the abutment on one side over four piers in the stream to the abutment on the other side.

Highway Marking and Signing.—The new highway marking and directional signs are for the most part much larger than those common in the United States and in most cases are blue and white. Located 1,000 meters from each turn-off is a sign giving the name of the village or town; then at 600 meters, 400 meters and 200 meters are smaller signs, which also indicate the distance in meters to the turn-off. These smaller signs are also blue and white and besides having the number



Special Overpass for Pedestrians.

Placing Bituminous Surface on Strip Along Edge of Slab.

In Many Cases the New Right-of-Way Passes Through Very Heavy Forests.

indicating the distance have diagonal bars across them, three bars on the 600, two bars on the 400 and one bar on the 200 meter sign.

Bus and Truck Traffic.—Many heavy busses and trucks belonging to the German Railway are operated over the part already finished. For the most part they are powered with diesel motors and operate at comparatively high speeds. Many of the bus bodies are very modern in their design, both as to appearance and conveniences for the passengers.

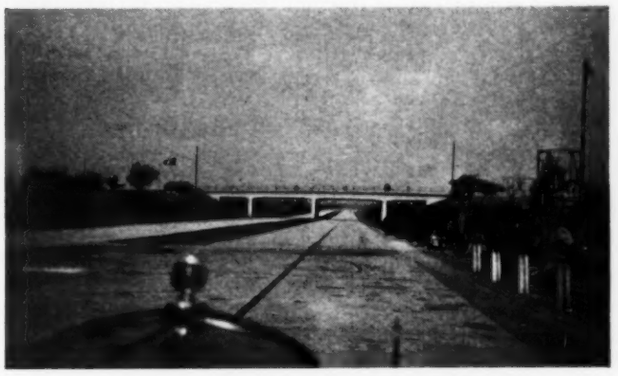
Service stations, or tanks as they are called, are operated by the Highway Department and are for the most part located near an overpass where they fit into the curves leading on or off the main highway slab.

Grading Operations.—In the construction of the highways, practically all of the hauling from the clearing through to the finish is done with the industrial railway, mostly steam, some diesel. In the construction of the grade, the trains are loaded in the cut, for the most part with power shovels. Here again both steam and diesel are used with the steam being the most common. There are cases, however, where the trains are loaded by hand and if the haul is not too long, or the grade too steep, the cars may also be moved by hand.

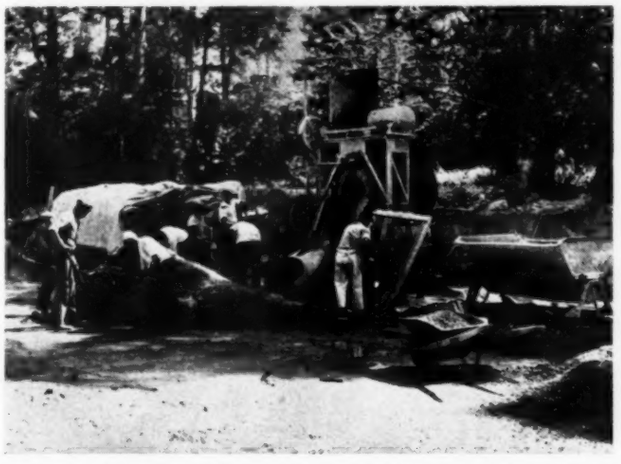
There Are Many Long Straight Sections. Three Over-Passes Can Be Noted in the Distance.

Compacting Fills.—In a few cases fills have been built the full height in one operation but the standard practice is to bring them up in lifts of 2½ ft. and compact them with some sort of heavy tamping equipment. A weight attached to the hoist line of a power shovel, from which the dipper had been removed, has been used on many of the fills. In some cases these weights weighed as much as 4½ tons but it was found that better results could be obtained with weights weighing much less.

Some special equipment mounted on crawler tracks has been used. These machines weigh about 25 tons



Overpass on Section North of Frankfurt.



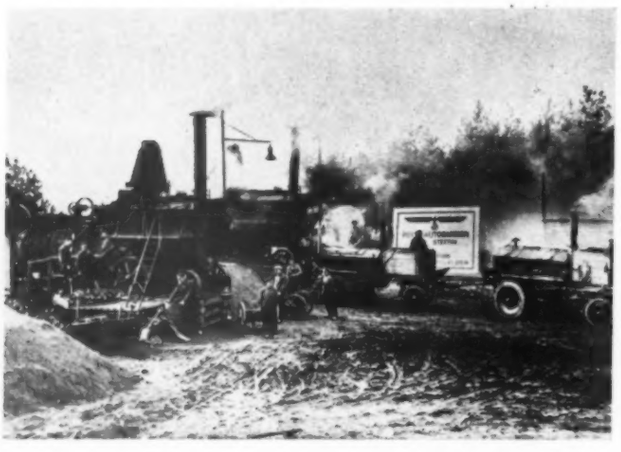
Type of Mixer Used for Culvert, Bridge and Other Similar Construction.

The Service Stations Are Located at Over-Passes Where They Are Very Nicely Fitted into the Curvals Leading on and Off the Main Slab.

The Over-Passes Are of Many Types in Design and Method of Construction.

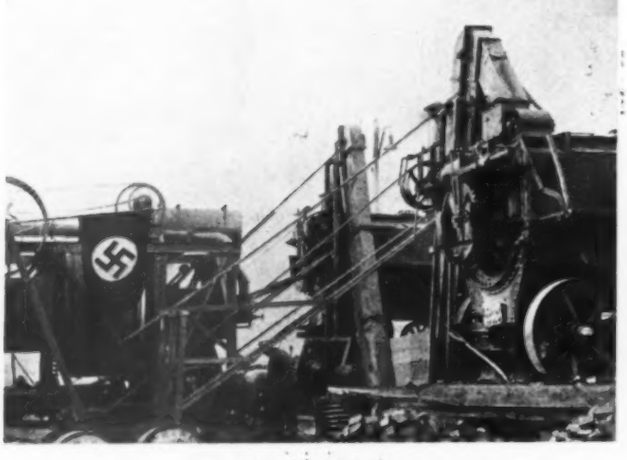
and one type carried four tampers weighing 1½ tons each. Another carried a very heavy vibrating tamper or rocker, which was operated with a 70 H.P. engine.

The Delmog Frog.—One of the most common units used for compaction is the Delmog Frog, which is made in sizes up to 2 tons. This is a self-contained gasoline operated unit constructed in such way that the impulse

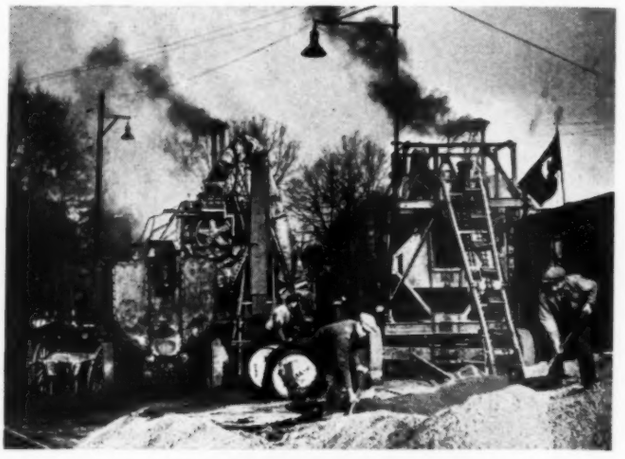


Mixing Bituminous Surfacing Material for Strip Along Main Slab.

from the gas charges causes it to bounce or hop over the material to be compacted, as the name would imply. The operator controls the direction of travel by a pair of handle bar like handles and ignites each charge separately by pressing a button located on one of these handles. The battery and other delicate parts of the ignition system being carried in a pack on the operator's back. According to recent reports 650 of these units were used during 1936.



Dryer and Mixers in Bituminous Plant.



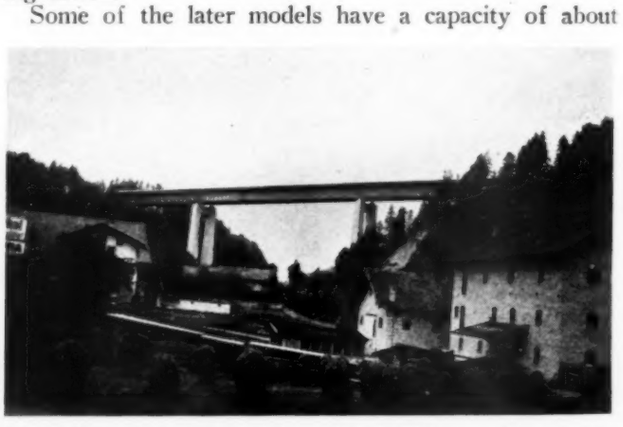
Feeding Dryer at Bituminous Plant.

Slab Construction.—In the construction of the slab, the concrete base for the bituminous strip along either side is laid first and used as a base for the form or track over which all of the paving equipment operates. Comparatively heavy railroad steel is used for this purpose. In cases where the grade is steep, a rack to engage a cog wheel on the equipment is also provided. In cases where the base for the bituminous strip cannot be used for a greater part of the form, a form somewhat like that in common use here is used, only that it is very much heavier, having the railroad rail built into it and in some cases the rack also. Because of the weight of equipment, which it must carry, these forms are often set in concrete which must be allowed to set-up before any equipment can be placed on them.

After the grade is prepared, a sand cushion is laid down with a special machine carried on the rails or forms. Back of that is a long frame carrying the rolls of paper in such a way that the paper for the full width of the base is laid down as the frame is shoved ahead.

The Paver.—Like all of the other equipment, the paver is carried on the forms and follows just back of the device, placing the paper. There are several makes being used, employing both the drum and pug-mill mixing action.

Some of the later models have a capacity of about



Most of the Long Bridges Are of the Continuous Girder Type. This Bridge Carries Two 24-ft. 6-in. Lanes of Concrete Pavement with 5-ft. Dividing Strip Between Them and Two 6-ft. Concrete Sidewalks.

The Directional Signs Are for the Most Part Much Longer Than Those Common in the United States.

70 cu. ft. and weigh as much as 40 tons. The material is brought to the mixer over an industrial railway, laid along outside of the forms. The skip comes down from the side of the mixer in such a way that the cars can be dumped into it, one car for a batch. The mixed concrete is discharged into a separate box which in operation, is somewhat like the boom bucket only that it is carried on a track running cross-wise of the slab. In some cases this track is part of the paver frame and in others it is a separate unit with its own power. The latter is the most common.

Finishing Operations.—For the most part the finishing machines are much heavier than those used in the United States, some of them weighing 10 tons or more. They all have the regular screeds at the front, which are followed by some sort of vibrating or tamping device. In some cases there is a series of tampers which cover the entire width of the slab at one time; in others, one or more tamping units are arranged to move about and cover the entire width; while in others a long vibrating pan is used. One make of machine is arranged to finish on a diagonal.

The contractor is required on all jobs to furnish a shelter over the hand finishing operation. This is usually a steel frame covered with corrugated iron and mounted on wheels in such a way that it can be moved along the forms. He is also required to cover the freshly finished concrete for 24 hours with a roof supported from the forms and in most cases uses the corrugated iron over sectional frame, which can be easily moved ahead. After 24 hours, the slab is covered with mats made of reeds and kept wet for the regular curing period.

The finish of the shoulders and back-slopes is very much the same as in this country. While there has not been time to do much work in the way of plantings, the indications are that in a few years the strip dividing the two slabs, as well as that on either side, will be a regular parkway. All of the slopes are being covered with several inches of a good rich loam.

▼

1,132-Mile Highway Opened to Traffic—The new road along the Libyan coast, from the Tunisian to the Egyptian border, has been completed and formally opened to traffic by the Premier of Italy. The road is about 1,132 miles long, 22 ft. wide. Of this mileage, 494 were constructed during 1936. The completion of this route makes it possible to motor the entire route between the Strait of Gibraltar and Cairo, Egypt, over first-class roads, except for a short distance along the seashore in northern Egypt.

Gasoline Consumed on Highways Increases 10.8 Per Cent in Year

Over 18 billion gallons of gasoline were used on the highways in 1936, according to statistics collected from state authorities by the U. S. Bureau of Public Roads. Consumption in 1936 increased 1,754,000,000 gal. or 10.8 per cent over that in 1935. Every state shows an increase over 1935 with the exception of North Dakota. Increases of over 15 per cent are recorded in Alabama, Arizona, Idaho, Mississippi, Montana, New Mexico, Oregon, Tennessee, Washington, and Wyoming.

Every State imposed a tax on gasoline, the rate ranging from 2 to 7 ct., and averaging 3.85 ct. for the entire country. The 10 states with the highest percentage increase in consumption all imposed taxes of 5 to 7 ct., Wyoming excepted, where the rate is 4 ct.

The state taxes, including miscellaneous receipts of collecting agencies, yielded a total income of $691,420,000 as compared with $619,677,000 in 1935.

Over 641,000,000 gal. of gasoline were exempted from the tax because of non-highway or public use. Refunds of $37,000,000 were made, largely for non-highway use.

The following table shows tax collections by states:

State	Tax Cents Per Gallon	Gallons Taxed for Highway Use	Net Total Receipts
Alabama	6	199,040,000	$ 11,803,000
Arizona	5	79,509,000	3,843,000
Arkansas	6½	148,276,000	9,235,000
California	3	1,459,993,000	43,008,000
Colorado	4	172,661,000	6,833,000
Connecticut	3	287,218,000	8,835,000
Delaware	4	47,067,000	1,856,000
Florida	7	288,079,000	20,317,000
Georgia	6	298,673,000	17,493,000
Idaho	5	74,701,000	3,696,000
Illinois	3	1,123,332,000	33,819,000
Indiana	4	525,909,000	21,154,000
Iowa	3	411,544,000	12,196,000
Kansas	3	316,438,000	9,520,000
Kentucky	5	228,333,000	11,277,000
Louisiana	[1]7	212,547,000	12,207,000
Maine	4	127,513,000	5,202,000
Maryland	4	226,536,000	8,921,000
Massachusetts	3	624,930,000	18,448,000
Michigan	3	871,512,000	25,739,000
Minnesota	3	404,426,000	12,329,000
Mississippi	6	151,880,000	9,062,000
Missouri	2	548,211,000	11,188,000
Montana	5	90,447,000	4,455,000
Nebraska	5	223,222,000	11,320,000
Nevada	4	27,420,000	1,080,000
New Hampshire	4	78,748,000	3,181,000
New Jersey	3	657,854,000	19,106,000
New Mexico	5	69,546,000	3,410,000
New York	[2]3	1,619,122,000	55,709,000
North Carolina	6	335,097,000	20,961,000
North Dakota	3	77,021,000	2,301,000
Ohio	4	1,078,255,000	43,450,000
Oklahoma	4	332,243,000	13,216,000
Oregon	5	186,092,000	9,218,000
Pennsylvania	4	1,277,225,000	49,383,000
Rhode Island	2	114,400,000	2,230,000
South Carolina	6	160,810,000	9,695,000
South Dakota	4	98,447,000	4,186,000
Tennessee	7	252,665,000	18,158,000
Texas	4	958,957,000	38,471,000
Utah	4	77,912,000	3,088,000
Vermont	4	57,697,000	2,277,000
Virginia	5	299,102,000	14,714,000
Washington	5	313,740,000	14,345,000
West Virginia	4	174,630,000	6,810,000
Wisconsin	4	452,509,000	18,028,000
Wyoming	4	55,482,000	2,254,000
District of Columbia	2	121,625,000	2,393,000
Total weighted average (rate 3.85 cents)		18,018,596,000	$691,420,000

[1]Increased from 5 to 7 cents on July 28, 1936.
[2]Decreased from 4 to 3 cents on July 1, 1936.

INTERSTATE EMPLOYMENT

Second of a Series of Articles on the Federal Social Security Law As It Affects Contractors

By GEORGE P. ELLIS, C.P.A.
Wolf & Company, Chicago

SEVERAL readers asked last month how the decisions of the United States Circuit Court of Appeals in Massachusetts[1] holding the Federal Social Security Act unconstitutional, affected their tax liability.

The first point in answer is that the Federal Social Security Act is operative until the United States Supreme Court holds it unconstitutional. A decision by the highest court may be made comparatively soon, since there are a number of cases before it on appeal.

Meanwhile the Bureau of Internal Revenue has warned that full penalties ranging from 5 to 25 per cent will be collected from delinquent tax-payers if the High Court upholds the law.

Even if the federal law were held unconstitutional, a number of the state laws would still be operative. Some of the state acts expressly provide that if the federal law is held unconstitutional, the state law will still continue in full force within the state. For example: the state laws in New York, Pennsylvania, California, Wisconsin—to mention a few—are not dependent upon the federal act. On the other hand, the Texas law provides that all tax liability ceases in the event the Federal law falls, and that the money paid into the state unemployment fund will upon proof, be returned ratably to those making such payment.

This question emphasizes again the importance of settling in what states an employer has unemployment tax liability. The problem is very simple in intra-state business, where very little if any employment is outside the state; it is increasingly complicated where employment is distributed in several states each with different requirements. A working formula has been developed which meets most of the difficulties on the matter of tax payments. The matter of where benefits will accrue and become payable for the migratory workers is a problem still to be worked out when state unemployment benefits become payable.

Unemployment benefits are paid only from state funds under state laws. Most of the laws provide benefits after 1939 or 1940. All states except Florida, Illinois and Missouri have enacted unemployment compensation laws.

The Federal Social Security Taxes on employers are of two kinds:

(1) An unemployment compensation tax, paid *annually* on total payroll—excepting, certain exempt employments—of employers of eight or more within each of 20 weeks. Only employers pay this tax.

(2) An Old-Age Benefits tax paid *monthly* on the first $3,000 of wages of each employe—excepting certain exempt employments—by employers of one or more persons. Both employers and employes pay this tax.

The State Social Security Taxes are paid for unemployment insurance *only*. There is much variation among the state laws as to the employers who are subject, the amount of tax, the time of payment, etc. Some states require employes to contribute to their own unemployment insurance. Time of payment of state taxes is weekly, monthly, quarterly, even annually.

But the state tax (in states which have unemployment taxes) must be paid in full by the employer before he can claim his 90 per cent credit against the annual Federal Unemployment tax. This works out as follows:

1936 Fed. tax	1.0%	
A 1936 State tax say.....	.9%	
Total tax	1.9%	
Fed. allows 90% credit for payment of a state tax. 90% of 1% = .9...	.9%	credit against Federal on a/c of paying a state tax.
	1.0%	net tax (State and Federal).

The usual definition of "employment" is that "only employment in which all or the greater part of the person's work is performed within the state is subject to the state act." Furthermore, if most of the work is done within the state, and the work outside the state is incidental to the work *within*, then the total employment both within and without the state is reported entirely in the state where most of the employment occurs.

The real question arises when employment is so spread that it cannot be said to be more in one state than in another. The general formula then is:

That employment is "localized" for tax purposes in the state where all or the greater part of the work is performed.

The tests used to determine where employment is "localized" for tax purposes, when the greater part of the work is not performed in any one state, are these:

(1) If the base of operations is in a state where some of the work is performed, the employment is reported for tax purposes in that state.

(2) If there is no base of operations in a state where some of the work is performed, but the place from which the work is directed or controlled is in one of these states, then the employment is reported for tax purposes in the state where the source of direction is.

(3) If there is neither a base of operations nor a source of direction or control in any of the states where the work is performed, but the worker's residence is in one of the states where the work is performed, the employment is reported for tax purposes in the state where the employe resides.

In "localizing" the employment of a construction crew, where skilled or supervisory employes or keymen are sent from headquarters and a local crew is engaged at the site of the work, a line is drawn between the supervisory staff and the local staff. The most conspicuous rulings of this point have been issued by Indiana. Under these rules, the supervisory and skilled staff would be reported in the headquarter's state and the local workers would be reported in the state where the work is performed. If some of these local workers happened to live across a state line, their work would

[1] *Geo. P. Davis, Plaintiff, Appellant,* v. *Boston & Maine R. R. et al., Appellees,* Oct., 1936, No. 3213, decided 4/14/37.

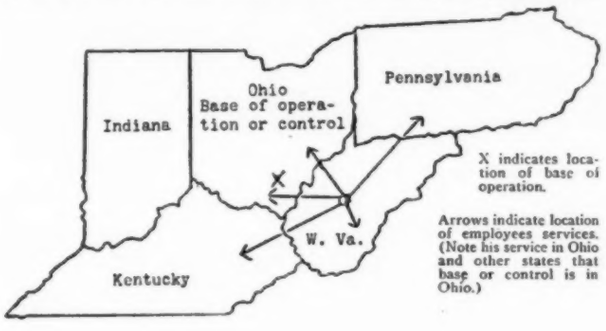
be reported in the state where the work was done, rather than in the state of residence—unless other factors were determining.

A few states—Kentucky, Louisiana, and South Carolina—reach the roving worker in another way by "localizing" his employment where the "contract of hire" was signed.

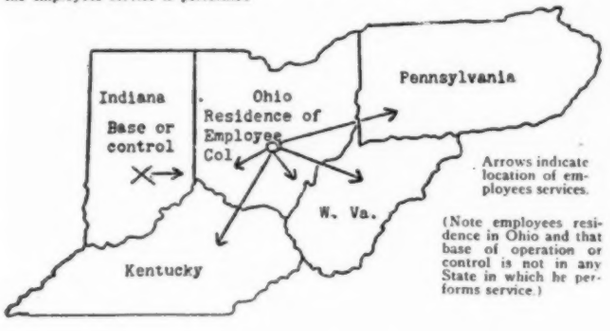
The Ohio Commission has sought to diagram its definition of employment in the following chart:

A Worker's Services Are Deemed to Be Performed within Ohio Under the Following Conditions:

1. "The service is not localized in any State but some of the Service is performed in the State of Ohio and (i) the base of operation, or, if there is no base of operations, then the place from which such service is directed or controlled, is in the State of Ohio.


Indiana
Ohio
Base of operation or control
Pennsylvania
X indicates location of base of operation.
Arrows indicate location of employees services. (Note his service in Ohio and other states that base or control is in Ohio.)
W. Va.
Kentucky

2. The employees residence is in Ohio, but the base of operation or place from which such service is directed or controlled is not in any state in which some part of the employees service is performed


Indiana
Base or control
Ohio
Residence of Employee
Pennsylvania
Arrows indicate location of employees services.
(Note employees residence in Ohio and that base of operation or control is not in any State in which he performs service.)
W. Va.
Kentucky

Another complication is the unit of employment as used in some states. In California, the unit of employment appears to be the week. New Hampshire held that a majority of the working hours in any payroll reporting period constituted the basis of employment in the state.

The District of Columbia determines liability to District tax on the basis of where the greater part of the unit of employment covered by the contract was performed. It may be a day, a week, a year—or a job. The unit of employment can be so variant that the District goes on to establish these rules:

(a) If employes are hired for a specific job, the greater part of their services will be deemed to be performed at the location of the job.

(b) If employes are hired for and assigned to a definite place of work, the greater part of their services will be deemed to be performed at the place thus designated.

(c) If employes have no continuous or regular place of work but it is not readily apparent where the greater part of their services are performed, such greater part will be deemed to be performed at the residence of the employer.

The variations among the state laws in the definition of employment are gradually being ironed out as one law after another is amended and greater uniformity develops. And the progress toward uniformity will no doubt be greater once the constitutionality of the Federal Act is settled.

Another point to watch, is the particular state provision as to when liability attaches. In the most of the states, an employer who becomes subject to the state act during a calendar year is liable for taxes for the *entire* year. Thus, an employer who does not have enough employes to be subject to a certain state act during 10 months of the year may be obliged to put on additional help and so become liable in the eleventh month for a full year's contributions. Where the state coverage is eight employes at any time, and an employer has only seven most of the year, the addition of extra help late in the year may entail a considerable tax liability. Employers who might find themselves in that position should consider the advisability of setting up a reserve for the contingency.

A recent check showed that only in Connecticut, District of Columbia, New Hampshire, New York and Wisconsin did liability attach for the fraction of a year from the date the employer became liable.

Another factor to watch for, is the "employe contribution," which is collected in nearly a dozen states. This employe liability may parallel the employer's monthly contribution from the beginning of liability, or it may be a short-term levy as in Indiana. Under Indiana's recently amended law, the employe pays 1% only on his first quarter's earnings (January 1-March 31). And employe contributions are not collected the entire first year that the employer is subject to the state law. In other words, an employer of eight in 1936, is subject to the Indiana law in 1937, and an employe's tax will be collected. If the employer had had only seven employes in 1936, and eight in 1937, there would be no employe's tax in 1937.

A question has been asked by a Mississippi subscriber: "Should an individual record of payroll be kept? What other reports will have to be made to the government besides the monthly report of total payroll?"

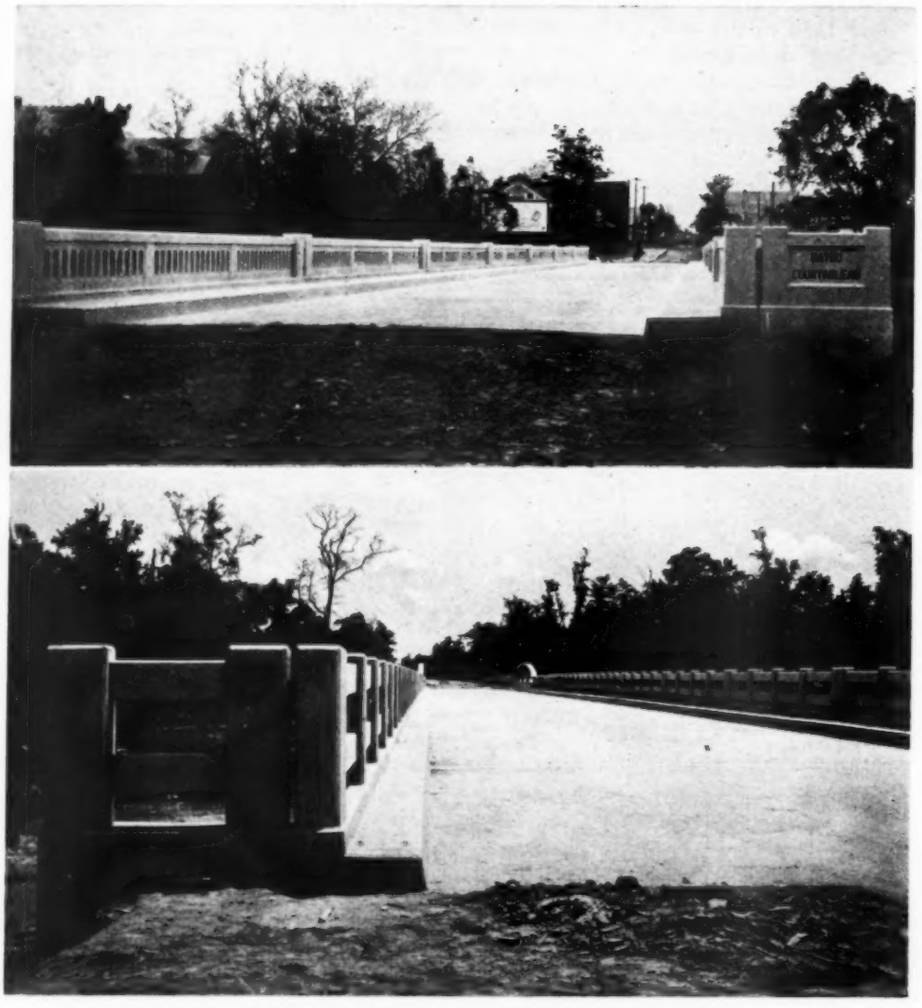
The question refers to Old-Age Benefits tax returns and records. The Federal Old-Age Benefit return is a monthly report and payment. A detailed six months' summary O. A. B. report for the period, January 1, 1937 to June 30, 1937, will be required in July on Forms SS-2 and SS-2a, which have not yet been released. After this six months' summary, similar quarterly summaries will be required. On these detailed summaries, employe account numbers will be required and individual payroll data.

In addition to these tax returns, the employer must be able to give from his records the information required on employes reaching the age of 65 since January 1, 1937. In general, it is advisable that he have on his records the employe's name, address and account number, occupation, taxes, dates of beginning and ending of employment, all remuneration by periods, taxes deducted, and separation of wages subject to tax from wages not subject.

A whole series of Forms OAC 1001-1006 covering lump sum benefit claims for employes reaching age 65 after the beginning of 1937 or dying, has been released. Every employer should have these forms on file and study their requirements. Only two weeks' time is allowed for filing after the employe or his estate becomes eligible to benefits, and some of the requirements could not perhaps be filled immediately, if the records were not as complete as possible.

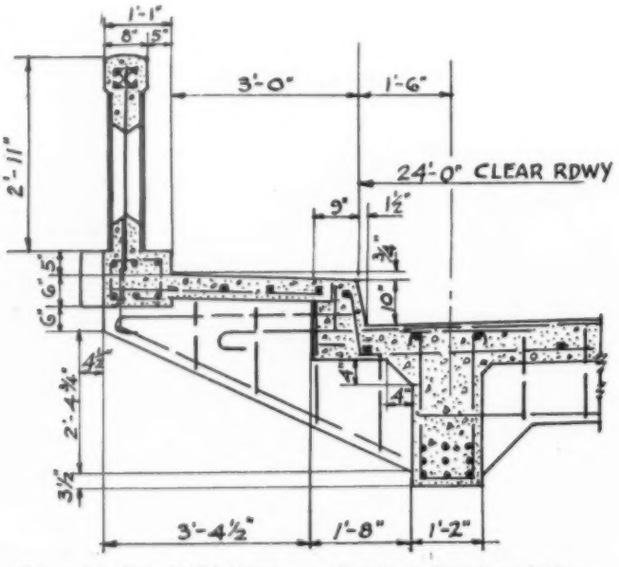
LOUISIANA BRIDGE WALKWAYS AND PATHWAYS

THE accompanying details and photographs show standard provisions of the Louisiana Highway Commission for pedestrians on bridges. The minimum provision is what is known as the "broad curb" or "pathway." It has a surface width of 1 ft. 2 in. and a height of 10 in. above the roadway. Although its essential function is to provide a refuge for pedestrians, it is also usable as a single path walkway. All new bridges constructed under the Commission's jurisdiction have at least this much pedestrian space on each side. Where traffic is heavier there is a 3-ft. sidewalk or "walkway," this also having a curb face of 10 in. Where still wider walks are needed, the construction is according to special design.

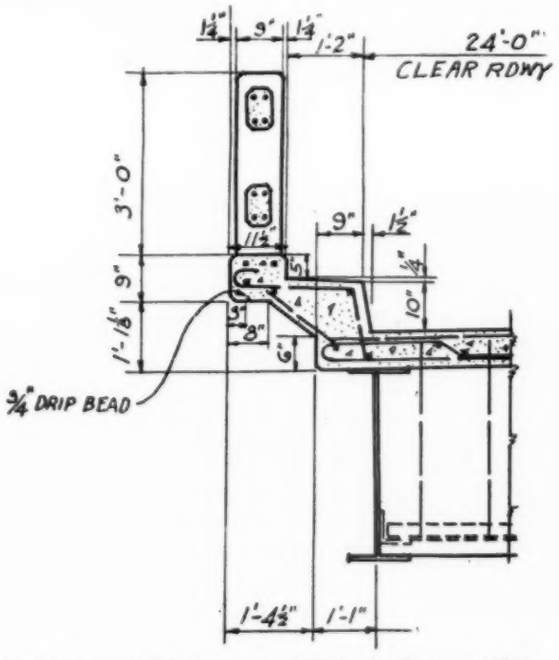


Upper Picture—Bridge with Standard 3-ft. Walkways
Lower Picture—A Standard 1-ft. 2-in. Pathway

Details and photographs are by courtesy of the Louisiana Highway Commission.



Cross Section of Walkway on Standard Reinforced Concrete Deck Girder Span with Type C Handrail



Cross Section of Pathway on Standard 56-ft. to 80-ft. I-Beam Span

Initial Step in Stage Construction at Shillington, Pa. —Base Consisting of Broken Stone of All Sizes Bound with Limestone Dust

STREET IMPROVEMENT BY EASY STAGES

By A. M. LaSOR
The Texas Company

SHILLINGTON, PA., is a suburb of Reading, located southwest of the city along the Lancaster highway. It is a thriving community and has more than doubled its size in the last 15 years.

Due to this expansion, new streets have had to be constructed each year, and owing to the rapidity of the development in relation to the funds available, it was found necessary to build the maximum yardage of streets at the lowest possible cost. A system was adopted of spreading street improvement costs over a period of years, incorporating construction and maintenance charges.

Bases for new streets were constructed of run-of-quarry crushed stone to a depth of 10 to 12 in., bound with limestone screenings and subjected to traffic and weather for several months. After satisfactory compaction had been attained, the surface was trued up and primed with ⅓ to ½ gal. of Texaco No. 45 surfacing material, a light asphaltic oil, and opened to traffic until the following year. At that time a somewhat heavier asphaltic oil was applied and covered with 20 to 25 lbs. of ½ in. limestone chips. This became the wearing surface for another year, when either an application of the same asphaltic material covered with ½ in. chips, or a treatment of hot asphalt covered with 35 lb. of ¾ in. limestone, was made, depending on the condition of the surface.

When the hot treatment stage is reached, the street is finished and the experience of Shillington has been that they can expect 4 to 8 years of service before another treatment is required. For the hot treatment, several different grades of asphaltic material have been employed with satisfactory results, the selection being determined by the condition of the surface prior to treatment.

This stage system of street improvement has resulted in a group of streets of excellent appearance at a cost

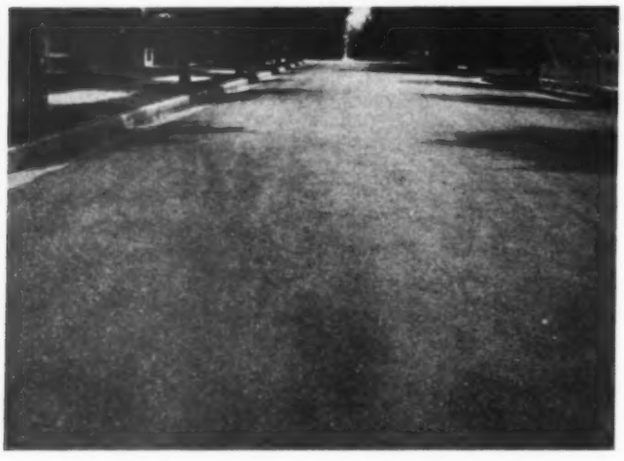
Second Stage—Broken Stone Base Receives Application of ⅓ to ½ Gal. of Texaco No. 45 Surfacing Material, a Light Asphaltic Oil

Fourth Stage—A Hot Application of Heavy Asphaltic Surfacing Material Is Made and Covered with ¾ In. Stone

over a 12-year period of about $.05 per yard per year, including original cost and maintenance.

Cracking and raveling of the street surface have been entirely absent and the only patching found necessary has been for repairs due to service-cuts necessitated by new homes which have mushroomed in this beautiful town.

The maximum number of treatments any street has had in the 12-year period has been four, one of the light asphaltic material, two of the somewhat heavier



This Street Was Treated with Emulsified Asphalt in Place of the Hot Application

asphaltic material, and one hot treatment. A variation was tried in 1933 when emulsified asphalt was used in place of the third treatment and also to replace the hot application. In the three years elapsed since then, the emulsion has shown every indication of success, in place of the hot asphalt.

The advantage of planned stage construction for communities with limited funds is obvious. Such a system enables the street department to spread the available funds over a large yardage, giving a greater number of taxpayers clean, dustless streets during those years when the construction is gradually taking place, instead of concentrating funds on the improvement of a small yardage of entirely completed streets each year. It also is doubtful whether a $.60 per square yard street would give 12 years of wear without maintenance. The stage-construction, because of its flexibility, permits the meeting of conditions as they develop, i.e., modifying each stage to take care of base failures or varying traffic loads, so that when completed all sources of failure should be corrected.

▼

Highway Maintenance Organization in Wayne County, Mich.

In Wayne County, with the taking over of the subdivision streets and alleys in recorded plats outside of incorporated cities and villages, road service, maintenance, and betterments have to be provided for some 2,300 miles of roads, streets and alleys now under the jurisdiction of the Board of County Road Commissioners. This mileage may be divided as follows:

	Miles
Main County arteries	480
County-Township roads	682
Subdivision streets	778
Subdivision alleys	376

The roads are scattered over 626 square miles in 18 townships. The organization perfected to take up these roads is as follows:

An engineer is in general charge of the work. With the aid of an assistant engineer and a general maintenance superintendent, he looks after all phases of the work.

For the purpose of carrying out the routine work, the county is divided into seven districts, with a district foreman in charge of each. They are in direct charge of the work being done in their districts, whether it is patching concrete surfaces, sweeping gutters, mowing weeds, or any other phase of the work.

The sign foreman is in general charge of the painting and installation of all signs and markers.

Two inspectors are in charge of all work done under permits, such as the installation of utilities' pipe lines, sewers, etc. These men are deputized and also act as weighmasters for enforcing the load limit laws.

Four maintenance yards have been established to aid in carrying on the work. The Wyoming Yard on Wyoming Avenue and the Pennsylvania R. R., serve as maintenance headquarters. All major repair work of maintenance equipment is done in the repair shop located at this yard. The sign and paint shop is there also. Equipment and materials are also stored at Goddard Yard on Goddard Road at the Pennsylvania R. R.; at the Wayne Yard in Wayne, Michigan, and the New Boston Yard, located on Sibley Road, at the Pere Marquette R. R.

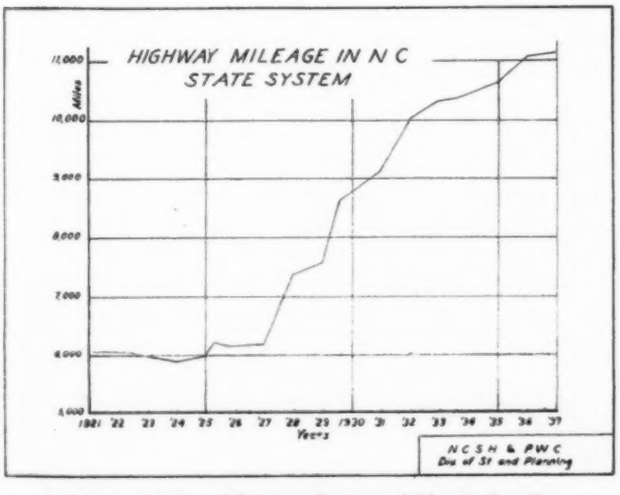
There is practically no cast-in-place concrete sidewalk in Germany. Walks are made up either of precast concrete sections or small stone blocks laid in sand. Some of them are in very beautiful patterns.

NORTH CAROLINA HIGHWAY PROBLEMS -- OBSERVATIONS ON CERTAIN PHASES

By VICTOR J. BROWN
Publishing Director, Roads and Streets

WHAT success has attended the move made in 1931 in North Carolina of placing all roads in the state under the jurisdiction of the North Carolina State Highway and Public Works Commission? The answer to this question involves a discussion of the growth of the state highway system as differentiated from the county highway system. (In this state there is no counterpart of the township road of the mid-western states.) It also involves a discussion of depression retrenchment. Naturally, diversion, the enemy of good roads, plays a close poker hand, always drawing a card to pair up with his hidden ace in the hole—relief.

Good roads sentiment in North Carolina is not a crystallized motivating force. More of a "laissez faire" attitude, obtains, even shading into the "highway holiday" opinion, so far as high type pavements on main routes are concerned. The one redeeming feature about the attitude in general is the incessant stream of delegations from the counties requesting this or that road be weatherproofed and the demand for a higher maintenance standard on county roads. While being a redeeming feature in the stimulation of good roads attitude, it likewise is factual evidence of the limitations of the North Carolina law with respect to finance. A fundamental tenet of taxation is violated by the present law, viz., that he who requests an improvement should expect to pay for it. No provision is made in the North Carolina highway laws by which county road improvements can be assessed against benefiting or petitioning parties. Naturally, the commission is besieged with county delegations from the 100 counties of the state; these delegations knowing that their petitions will not result in increased special taxation upon them.



Mileage of State Highway System of North Carolina

The author of this article wishes to thank the following officers of the North Carolina State Highway and Public Works Commission for their help, opinions, and discussion:

Capus M. Waynick—Chairman (as of April 15, 1937.)
W. Vance Baise—State Highway Engineer
B. W. Davis—Equipment Engineer
James S. Burch—Engineer of Statistics and Planning
Boris B. Petroff — Assistant Statistical Engineer

The article does not necessarily reflect the opinions of these men. In fact, there is not complete agreement with the author in some cases. The article portrays the picture as seen by the author.

Growth of State System

In 1921 the state decided to adopt a 5,000-mile state highway system. At that time the commission planned to adopt 6,000 miles and eliminate 1,000 miles by relocation, elimination of curvature and elimination of duplicating routes. A $50,000,000 bond issue was created to accomplish the task. In 1925 a small bond issue was sold and more miles added. A total of 115 million dollars in bonds has been issued for construction of the state highway system, which now comprises 11,118 miles, about 78.5 per cent of which is bituminous surface treated or hard surfaced. Over one-half of the present state highway system was built prior to 1926 on designs calculated to accommodate traffic existing and anticipated at that time. An inspection of the system shows that excellent engineering and foresight was employed on the first big program.

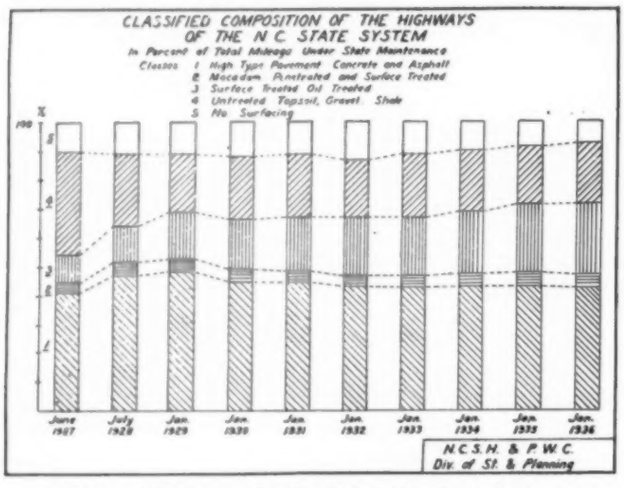
As the demand for better roads increased, based on benefits already appreciated, the state highway mileage also increased at a rather constant rate, as noted in the accompanying curve.

At the present time debt service requires an annual allocation, of gasoline taxes and motor vehicle license fees not yet diverted, of some $9,000,000. By the end of 1928, without the aid of any property taxation, the state system consisted of 7,550 miles of improved highways. At that time the system was 47 per cent hard surfaced with high type pavement.

Today we find this system has grown to over 11,000 miles, more than double the original plan. Undoubtedly political changes in the commission had considerable to do with this growth. Had it not been for increasing prosperity and lack of reflection of the depression in budgetary commitments up to 1932, the commission would have found itself out on a limb. Finances were readily available, however, up to that time.

Practically no state funds have been spent for many years on new construction and reconstruction, except for matching Federal Aid. Had it not been for the federal emergency allotments, it is probable that practically all of this type of work would have ceased about 1933. Such federal funds may not be anticipated in the future. Current and anticipated income precludes any major construction by state funds. Traffic demands are increasing; state roads and bridges are depreciating; obsolescence marches on; diversion gnaws at the vital spot of highway development—progressive construction. Thus we see a state highway program floundering along in a rough sea, like a ship without sufficient power; a job to do, without adequate funds with which to fire the administrators' and designers' imaginations and ambitions.

Furthermore, the ship's officers have no difficulty in observing over the horizon of the year, additional rough water, as the present high-investment pavements approach the end of their serviceable lives.



Types of Highways in North Carolina State System

The position in which the commission finds itself, with respect to improvement of the state highway system, is no different, proportionately, than it was 10 years, or even 15 years ago. The accompanying chart by years from 1927 to 1936, inclusive, shows this fact graphically. The mileage of state highways each year is taken as 100 per cent. The chart shows that only a little over 43 per cent of the system is surfaced with high type pavement; and that this percentage has varied but slightly over a 10-year span; despite constant improvements in the nature of new construction.

Add to all this, the responsibility of 47,000 miles of country roads, without increased income per mile to take care of these roads, and answer for yourself—How many miles of improved construction on the county roads can the state accomplish? It is true that field investigations show that the state has maintained the county roads to a slightly higher standard than did the counties, but can the state afford to still further raise the standard of county road maintenance to comply with the demands of the modern rural citizen? Herewith are tables of state and county road mileages by types. Herewith, also, are tabulations of revenues and expenditures in recent years:

MILEAGE OF HIGHWAYS IN NORTH CAROLINA
JANUARY 1, 1936

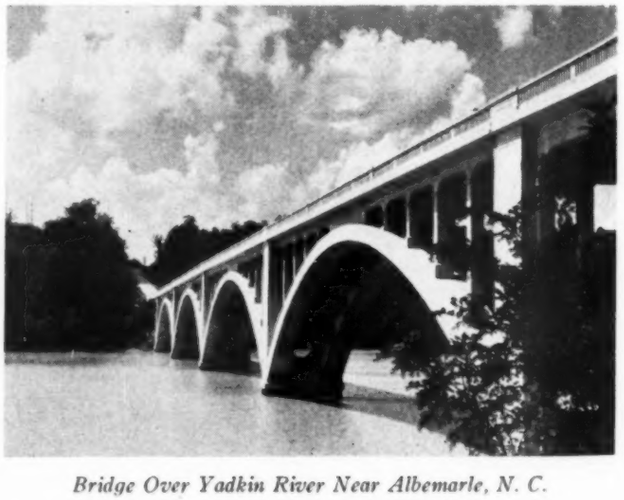
	State System	County System
Unimproved	214	10,046
Graded unsurfaced	559	20,349
Topsoil, sand clay	1,741	14,282
Gravel	328	1,064
Shale	55	65
Traffic bound macadam	126	166
Oil-treated sandclay, topsoil	2,326	554
Surface treated gravel	334	....
Surface treated macadam	489	31
Penetration macadam	84	121
Brick	9	33
Asphaltic concrete*	1,820	166
Concrete pavement	2,689	170
Bridges over 500 ft.	22	3
In towns not maintained	248	....
Total	11,047	47,048
Grand Total	58,095 miles	

*Includes road-mixed and sand asphalt types.

NORTH CAROLINA MOTOR VEHICLE REVENUES*
RECENT YEARS

Fiscal Year Ending	License Fees	Gasoline Taxes	Total Revenue*
June, 1932	$5,480,705	$14,941,181	$20,421,886
June, 1933	5,005,610	14,165,026	19,170,636
June, 1934	6,683,528	15,165,221	21,848,749
June, 1935	7,482,463	17,333,677	24,816,141
June, 1936	6,885,804	18,809,411	25,695,215

*Does not include revenue from title fees, repaid loans, sundry—all of minor importance.



Bridge Over Yadkin River Near Albemarle, N. C.

NORTH CAROLINA STATE HIGHWAY AND PUBLIC WORKS COMMISSION
EXPENDITURES BY BROAD CLASSIFICATIONS IN MILLIONS OF DOLLARS
RECENT YEARS

Fiscal Year Ending June	Debt Service	State Maintenance and Betterments	State Construction Allotments	County Maintenance and Construction	Transfer to General Fund (Diversion)	Administration, Enforcement and Other	Total
1932	7.960	3.516	2.656	7.281	....	1.103	22.516
1933	8.445	1.976	5.502	4.660	....	1.074	21.657
1934	8.573	2.164	8.285	4.660	1.000	1.003	25.685
1935	8.959	2.884	6.345	6.542	1.000	1.002	26.731
1936	9.086	5.012	10.470	9.395	1.000	1.914	36.877

Maintenance of State Highways

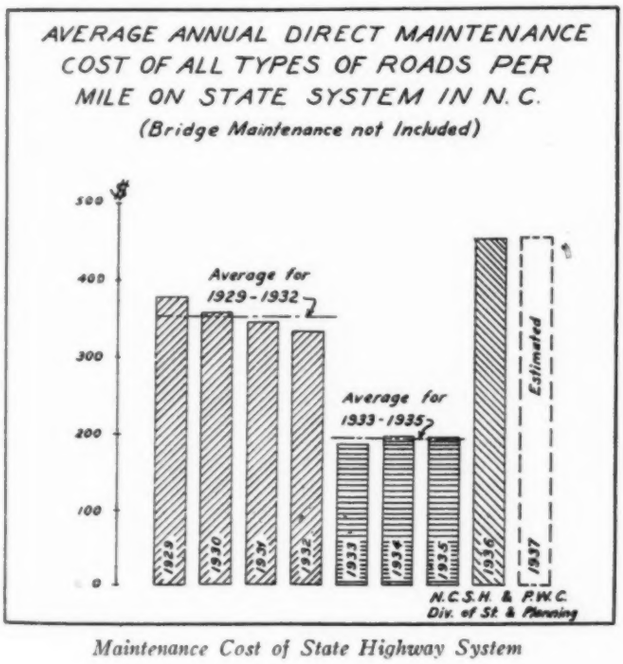
The subsequent discussion is not designed to represent an exhaustive study of maintenance of the state highways, but rather to present in brief form a few significant observations. Information is not available in North Carolina at the present time to evaluate the relative cost of needed maintenance for definite types of surfacing, nor on the effect of traffic and subgrades on these costs. Maintenance, in one state, does not mean the same thing as in some other state, so this discussion will be confined to maintenance as meant by North Carolina. Like other states, the figures reflect budgetary allowances for this activity rather than expenditures required to keep roads up to a certain standard.

From the records we obtain the average maintenance expenditure per mile for recent years, regardless of the type of road and location. Following is a table that forms the basis of this discussion:

AVERAGE ANNUAL MAINTENANCE EXPENDITURES IN DOLLARS PER MILE
(Bridge maintenance not included)

January Year	Regular Yearly Maintenance (A)	Betterments (B)	Direct Maintenance, Regular Maintenance, and Betterments (C)
1929	$235.21	$143.81	$379.02
1930	188.47	166.47	354.94
1931	248.45	97.29	345.74
1932	241.66	91.79	333.45
Average 1929-1932	$228.44	$124.84	$353.29
1933	$165.90	$ 20.70	$186.60
1934	152.97	43.63	196.60
1935	169.66	25.24	194.90
Average 1933-1935	$162.84	$ 29.86	$192.70

These data are also indicated graphically in the accompanying chart. The table and the chart indicate that the roads, during the period of 1933-1935, were not maintained to the degree previously accomplished. The 1929-1932 period may be described as one of normal activity in maintenance. The composition of the system had not changed materially, improvements by construction were neutralized by added unimproved mileage. Expenditures during the earlier period were not excessive and there is no indication that administration and execution of highway work was inefficient. Much mileage was passing into "middle age," thus requiring heavier betterment outlays. This 1929-1932 period may be taken as normal. July 1, 1933, witnessed a state system in fairly good condition, so far as maintenance was concerned. Since much of the mileage is intermediate and low cost types, annual and periodic maintenance to a standard is mandatory for satisfactory highway service. Figures of the earlier period indicate that about $350 per mile per year would accomplish the desired result. Check this with the average expenditure of $193 for the later period, and it will be seen that the later period was only slightly over one-half the amount of the previous period of normal requirements.



Maintenance Cost of State Highway System

"Devils Head" Chimney Rock. U. S. 74 in Lower Background.

The average direct maintenance cost per mile (Col. C) during the later period dropped 45.5 per cent below the average for the prior period; whereas regular yearly maintenance (Col. A) dropped only 28.7 per cent. This difference in ratios is obviously at the expense of betterments not made. The corresponding drop in the item of betterments (Col. B) was 76.1 per cent.

The significant indication of this fact is that all state roads had to suffer the effects of deficient maintenance, and that those sections which required frequent periodic improvement and replacement were almost completely neglected because of insufficient funds.

This enforced weakness on the state system in the fall of 1935, added to the detrimental effects of the adverse winter of 1935-36, developed a condition whereby about one-third of the total state highway mileage rapidly approached a condition of complete destruction. Thus it is obvious from the record, that the state had operated its highway maintenance for some two years or more at a level of expenditure below the adequate or optimism economic level, and that this adverse winter accentuated, rather than created the major part of the damage. Heavier maintenance expenditures were immediately mandatory. Fortunately, revenues had increased, developing a fund surplus which, by executive

Maintenance Crew Patching Surface Treated Roads on State Highway System

order, was made available for the necessary major repairs. Fiscal 1936 maintenance expenditures mounted to $456 per mile, or appreciably higher than the average of $193 for the immediately preceding 3 years. The difference between this "deficient" expenditure, and the recent "restoration" expenditure, is about $263 per mile, which, multiplied by the mileage on the system, represents a restoration cost for one year only of almost $3,000,000. Furthermore, it appears rather definite at this time that this 1936 intensity of effort and rate of expenditure will have to be continued at least through the fiscal year 1937, in order for the system to be restored to approach the condition existing four years ago, on July 1, 1933.

Thus, in the end, the extra cost of reconditioning may exceed what was thought to have been saved, and the public had inadequate road service in the meanwhile. The significant fact is that intermediate and low cost types of surfacing *must* be maintained faithfully and regularly. If not, destruction results and extra cost of reconditioning exceeds presumed savings.

County Road Problem

Unless the state highway commission can accomplish 300 or 400 miles of major county road betterments annually (only 3 or 4 miles per county), it is safe to say they are not doing the right kind of a job for county communities. Regarding maintenance, Prof. Marc C. Leager has shown, in Bulletin No. 8 of the North Carolina State College Engineering Experiment Station, that the state highway commission has taken better care of the county road system than existed prior to 1931. He states that in 1932, under commission management, the cost was about 11 per cent lower than the total 1930 cost to the counties. This economy was attributed to lower costs of materials and equipment, to better management, and to engineering and efficiency because of centralized control. Granting that the state has accomplished a high degree of efficiency in maintaining county roads, as based on the old standard, still a management which cannot show progress—orderly disorder of construction is not doing for its constituency what is normally to be expected. On the other hand, the commission can wave no magic wand, as it appears people are prone to expect. Funds must be provided and diversion of pledged funds stopped, if real progress is to be made; one might even say, if economic progress is to be made.

Under the present method of financing it is doubtful if much new construction will be put on county roads; delegations to the contrary, notwithstanding. If only 500 miles are built each year it will take 90 years to finish the whole mileage. Even then, the question would remain, could the state afford to maintain 47,000 miles of all-weather roads for the counties? If not, then why not return the county road systems to the counties and let them work out their own problems with state-aid, or else devise some method whereby land-service roads may be supported by land taxation? Those counties or communities that are willing to stand an abutting property tax for the benefits of an all-weather road can then proceed with improvements at will. As the matter now stands, gasoline and not property carries the burden of county road maintenance.

The Question

The question raised at the beginning of this article seems to be directly unanswerable at this time. Answers to partial phases may be given, but more time must elapse before a direct answer can be given. Indications are that state control of county roads in North Carolina has been beneficial and more economical than county control. Inspection of work and accomplishments shows better maintenance results, due undoubtedly to the fact that newer, heavier equipment can be employed, and the use of the equipment more efficiently supervised. Centralized control of equipment repair shops raises the

County Maintenance Crew Before State Took Over Control

shop standards, lengthens operating hours of equipment and permits continuous employment of skilled men, thus lowering unit costs of maintenance and construction output.

Adverse indications are that county delegations are continually petitioning the commission for new county road improvements, and the law makes no provision for creation of benefit districts on county road systems. Further, there is not enough new construction work on county systems annually. The people expect the magic wand to wave, to keep them satisfied it must be waved occasionally. Likewise on the state system, there is need for a larger annual mileage of high type pavement construction, and a special need for modernization through the elimination of danger spots such as narrow bridges, sharp curves, blind hilltops and insufficient superelevation of earlier construction. The elimination of diversion will help materially to meet these needs.

Bad Roads Tax

It is true that the more one pays in direct tax, the better the class and extent of highway service one may obtain (provided the tax collections are not diverted); but it is not true that one can always save money by lowering taxes, because the "bad roads tax" will require a heavier draft on one's finances than can be saved by failing to pay a "good roads tax." The motor vehicle owner pays for good roads whether he has them or not. The truth of this statement was demonstrated by Mr. James S. Burch, Engineer of Statistics and Planning, and Mr. Boris B. Petroff, Assistant Statistical Engineer, both of the North Carolina State Highway and Public Works Commission, about as follows:

Due to lack of factual data on certain factors, it was necessary in this study to employ data obtained in other states, to correlate this to North Carolina data, and to make certain broad assumptions. Therefore this study was not presented as a complete research study, but rather as a demonstration of a method whereby "the bad road tax" cost to vehicle owners may be evaluated and explained.

The average North Carolina passenger vehicle in 1935 traveled 8,440 miles and burned 587.6 gal. of gasoline. The state highway revenue from this car with a 6 ct. gas tax and a $9.00 license fee would be $44.26 for the year. Thus the per mile tax would be $0.00524 or about ½ ct. per mile. The average car traveled 25 per cent of its vehicle mileage on city streets, making 2,110 miles on city streets and 6,330 miles on rural roads. About 85 per cent of the rural travel is on state highways, thus we may list:

MILES COVERED BY AVERAGE NORTH CAROLINA PASSENGER CAR

On city streets	2,110 miles	25 per cent
On state highway system	5,381 miles	64 per cent
On county highway system	949 miles	11 per cent
Total	8,440 miles	

It is a well established fact that the type and condition of highway surfaces exert a direct influence on the cost of vehicle operation. So the following relationships have been set up:

RELATIVE COST OF MOTOR VEHICLE OPERATION AFFECTED BY CONDITION OF ROAD SURFACE

Excellent	100 per cent	Taken as index
Good	110 per cent	Of excellent
Fair	120 per cent	Of excellent
Poor	138 per cent	Of excellent

If we set up arbitrarily (but reasonably accurate) classifications of the North Carolina rural mileage by corresponding types of surfaces, and assume that the average North Carolina car covered a proportionate amount on these various parts of the system, we may construct the following table:

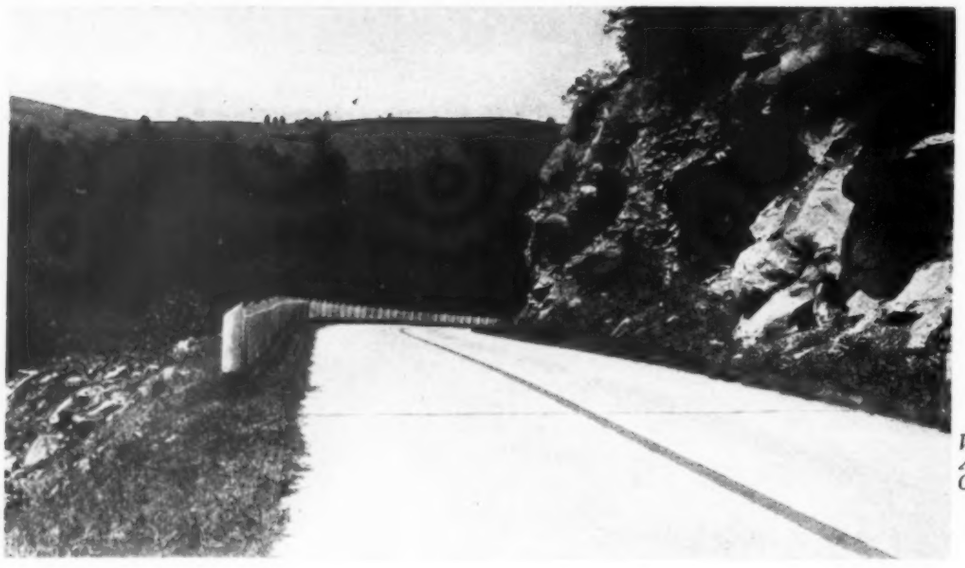
ESTIMATED ANNUAL TRAVEL AVERAGE NORTH CAROLINA PASSENGER CAR BY MILES ON VARIOUS CONDITION-RATED MILEAGES

System	Excellent	Good	Fair	Poor	Total
State	2,330	1,636	1,033	382	5,381
County	8	17	311	613	949
City Streets	....	....	2,110*	...	2,110
Totals	2,338	1,653	3,454	995	8,440

A study was made of detailed operating costs data of two large North Carolina fleet owners. It was found that during 1935 the average cost of operation per mile per vehicle was 3.66 ct. These cars traveled the whole state and it is indicated that their travel characteristics were such as to cover approximately proportional amounts of city streets, state highways and county roads

*City travel classed as fair because of high cost of stopping, idling, and frequent use of low gear ratios, even though street surfaces are excellent.

View on United States Route 64, Near Franklin, Macon County, North Carolina. Surface Treated Traffic Bound Macadam.



View on United States Route 74, Asheville to Hot Springs, North Carolina. Portland Cement Concrete Pavement.

of all types. This figure is based on accurate accounting and includes original vehicle costs, probable depreciation, interest, insurance, fuel, repairs, replacements, tires, lubrication and all items of cost chargeable to vehicle operation, including garage rent, taxes, overhead and management (no charge for driver).

This figure is for an annual operation of 16,216 miles while the North Carolina average vehicle covered 8,440 miles. Also the fleet owners obtained the price advantage of mass purchases. These are the reasons why the cost of operation of a passenger car per mile to the average owner will be considerably higher, although it is probable that the fleet vehicles were probably maintained at a higher level of efficiency.

After having analyzed and evaluated these adjustments it was assumed that a figure very close to 5.0 ct. per mile was the probable per mile cost of operating the average North Carolina motor car during 1935. Converting and relating this cost of 5.0 ct. per mile to the classified mileage, the operating costs per mile traveled by classes of roads will be as follows:

Excellent surfaces	4.363 cents per mile
Good surfaces	4.799 cents per mile
Fair surfaces	5.235 cents per mile
Poor surfaces	6.020 cents per mile

Recapitulating in terms of expenditures on various systems shows:

System	Excellent	Good	Fair	Poor	Total
State	$101.64	$78.50	$54.07	$23.00	$257.21
County	0.35	0.81	16.28	36.90	54.34
City Streets	.....	....	110.45	....	110.45
Totals	$101.99	$79.31	$180.80	$59.90	$422.00

(8,440 miles @ 5.00 cents per mile equals $422.00)

From this it is noted that the average annual cost of operation of the average North Carolina car is $422.00.

If, as happened during the years 1933-1935, maintenance of roads was not kept up and the road surfaces depreciated one class, i.e., excellent to good, good to fair, etc., the table above would become:

System	Excellent	Good	Fair	Poor	Very Poor*	Total
State	....	$111.81	$85.65	$62.19	$25.99	$285.64
County	....	0.38	0.89	18.72	41.72	61.71
City Streets	.....	.....	....	127.02	....	127.02
Totals	....	$112.19	$86.54	$207.93	$67.71	$474.37

*Estimated operating cost on very poor at 6.805 cents per mile.

Average cost per mile thus amounts to 5.621 ct. In the case just calculated the car owner spent $474.37 minus $422.00 or $52.37 more than at present per year as a "bad roads tax." The good roads tax was $44.26 per year, therefore the North Carolina average car owner would save $8.11 in operating costs alone by demanding and paying a good roads tax at the present rate. The calculations above indicate the necessity of regular, standard maintenance. The car owner pays cold cash for good roads whether he has them or not; more not, more cash.

Limestone Quarry Near Woodlawn, N. C., McDowell County, Showing One of the Crushing and Screening Plants Operated by the State Highway Commission.

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Reducing Sight to Improve Safety

In Waco, Texas, a circular intersection at the junction of five highways was originally constructed with the inside of the circle left flat to improve sight distance. Within a short time it was found that much confusion existed at this intersection. The problem was solved by reducing the sight distance and thereby confining the motorist's vision to items that were actually necessary for him to negotiate the circle in safety and with no loss of time. This was accomplished by placing a mound of earth six feet high within the circle covered with grass and low growing shrubs.

TRAFFIC SIGNAL TIMING IN CHICAGO

By W. C. BRANDES

Traffic Signal Engineer,
Bureau of Streets, Chicago, Ill.

A TRAFFIC signal is nothing more than an inanimate object by means of which colored lights are displayed for definite or varying periods of time. By defining each color or combination of colors so displayed and establishing fixed rules for vehicle operators regarding the indications we have provided a form of traffic regulation. It is a type of regulation which is economical, reliant, quiet, and for the most part, effective. Whether or not it is an efficient method of regulation depends entirely upon: (1) What is behind the signal in the form of motors, gear trains, relays and other electrical and mechanical "gadgets" which constitute the control unit that operates the lights; and (2) the amount of scientific knowledge that is applied in the determination of the proper operating characteristics of the intersection.

The Control Unit and Its Operation

Regarding the first item mentioned, that of the control unit, the most important requisite is sturdy construction and reliability of performance. Almost equally important, however, are the flexibilities of operation. Sufficient numbers of signal color intervals, and signal circuit contacts must be available to furnish the desired color sequences and timing for any job which the control might be required. Therefore, it should be designed with adequate provision for future requirements rather than present day needs. This is especially true in cities where almost every signal installation immediately becomes a potential part of a future coordinated system.

Assuming that ample flexibilities inherent in the control are available the competent traffic engineer can put in operation a sequence and timing of the signal color intervals which will efficiently pass that traffic constituting the reasonable capacity of the thoroughfares controlled. He will at the same time give sufficient consideration to the requirements and safety of the pedestrians, possibly going to the extent of providing especial pedestrian indications. He can go still further, for the benefit of vehicles, by correlating signals at the various intersections of a given street to provide nearly continuous movement along the thoroughfare at predetermined speeds.

In Chicago particular attention has been given to traffic signal timing with the objective that delays to traffic from signals in each and every installation be reduced to the minimum. Each case has been handled individually according to its own peculiarities rather than by any cut and dried formulae; and as a result varied and ingenious methods of timing have been devised each to maintain the highest possible efficiency and safety of movement. Some of the more outstanding types of signal timing and other variations of operation are briefly described in the following paragraphs.

Installations Involving Special Treatment

One of the first installations involving special treatment was made at the intersection of 111th St. and Longwood Drive. Here on 111th St., a traction street, is a short rather steep downgrade terminating immediately at the intersection with a boulevard, Longwood Drive, which passes traffic at fairly high rates of speed. Considerable hazard existed especially in the winter months due to inability of vehicles to stop safely on the hillside on a change of signals. In order to reduce the necessity for stopping on the grade an auxiliary one-way signal was placed on 111th St. at the crest of the hill. This signal when red stops vehicles on level ground. It then turns green a determined number of seconds before the green for that street appears at the intersection. Similarly the red light at the hill-crest leads the red signal at the boulevard intersection. The timing has worked very successfully and it is seldom that a vehicle of any kind is held on the downgrade.

Chicago, because of its section line development and its numerous diagonal arteries, has many important three-street intersections. Also in many cases the diagonal does not intersect the section lines at their common point but near thereto resulting in three separate and important intersections within a relatively small area. The shortest and longest distance between intersections varies in cases from 100 ft. by 270 ft. to 756 ft. by 1170 ft. The distances between intersections, width of roadways, volume and kind of traffic installation has somewhat different characteristics.

Installations for 3-Street Intersection

One of the earliest installations of this complex nature involved three intersections of major thoroughfares within distances ranging from 260 ft. to 380 ft., center to center of intersections.

The equipment was installed prior to the advent of flexible control mechanism on the market. However, the physical plan and traffic flow were exactly adaptable to a progressive form of timing with the use of only one control unit. It has functioned so successfully throughout the years that the control mechanism has not needed replacement by more up-to-date equipment. The intersections described are those of Kedzie Ave., Elston Ave. and Addison St. Another recent installation of exactly the same type is that of Ashland, Clybourn and Fullerton. Here a short total time cycle of 40 seconds is in use with signal changes at all intersections occurring simultaneously, though in a staggered plan for each street. Thus Clybourn Ave., the diagonal street, receives a green signal at Fullerton Ave. at 20 seconds on the time scale and at Ashland Ave. at 41 seconds. Ashland Ave. receives the green at Fullerton Ave. at 41 on the scale and 19 seconds later is given green at Clybourn Ave. Fullerton Ave. is timed similarly. Thus in six directions of travel traffic progresses from the first intersection to the second in approximately one-half the total time cycle of 40 seconds. See Fig. 1.

Another somewhat similar type, comprising three intersections closely grouped, are those of Damen, Elston

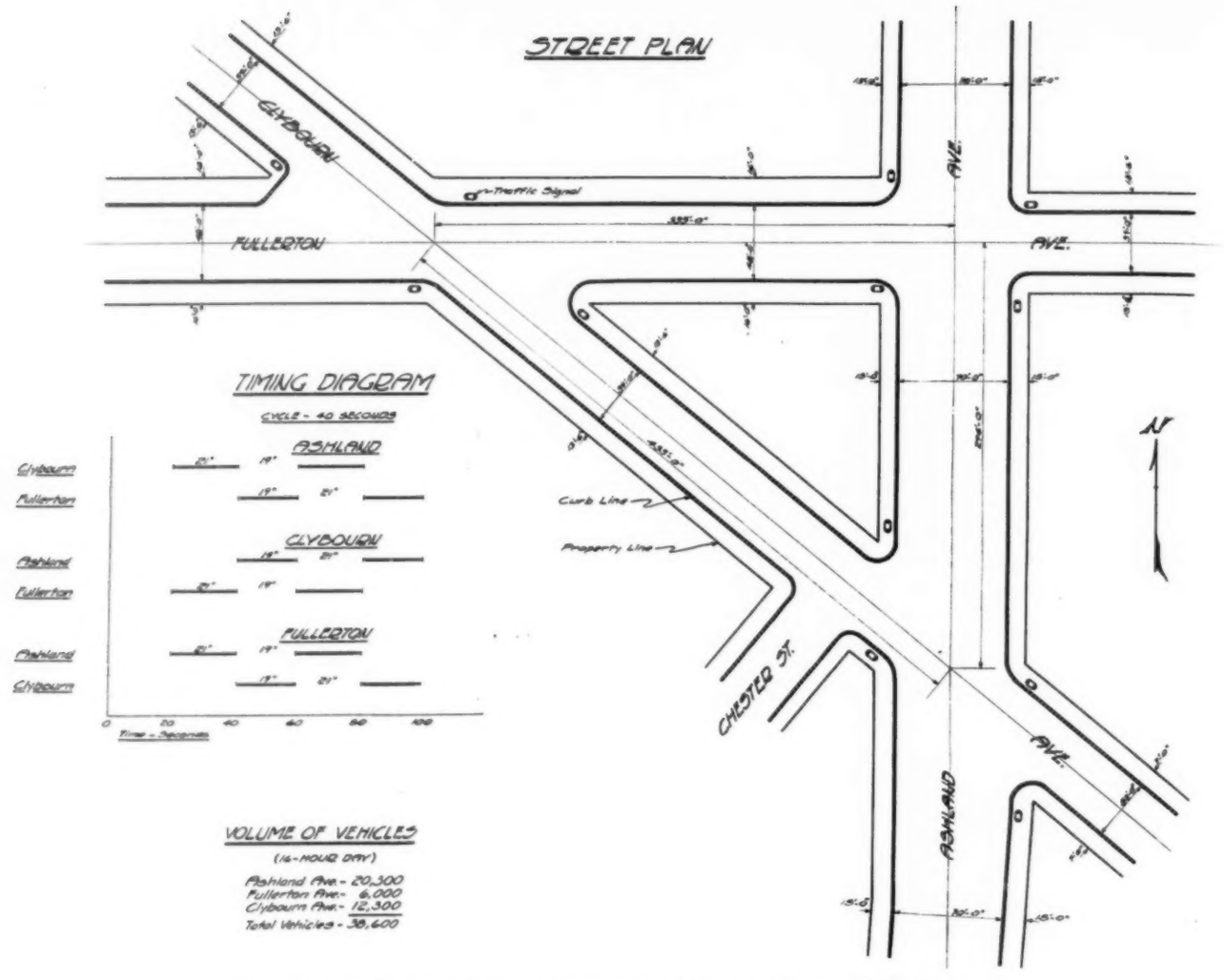

Fig. 1—Street Plan and Timing Diagram for Ashland, Clybourn and Fullerton Aves.

and Fullerton Aves. In this case the enclosed triangle is very small, a mere concrete platform. Each street forming a leg of the triangle has the green practically simultaneously at both its intersections while the lights on the diagonal street, the hypotenuse, is given the green on a staggered plan. In other similar cases one street is on a simultaneous timing while the other two approach a staggered scheme. Variations of the same type of intersection groups include California, Belmont and Elston; Chicago, Milwaukee and Ogden; and, Lincoln, Lawrence and Western. The length of cycle varies with the proximity of the intersections. In all of Chicago there are ten such groups of three intersections, each of which present variations of the timing schemes described under this type.

In the case of the older installations, as many as five control units were required, plus a master timer, to obtain the desired timing. Newer installations are operated by one control unit having as many as eighteen signal color intervals.

Installation at Two Important and One Minor Street

Frequently when three streets intersect in a common point one of the streets is of relatively minor importance and does not require a fixed period for movement each and every cycle. In this case it may be desirable to favor the more important streets by giving them two movements to one of the minor street. Three-phase vehicle actuated type of control will automatically skip a street in the absence of traffic on it. With fixed time control the same result can be accomplished by two methods. One is to lengthen the two major street movements by the amount given the minor street in alternate cycles, resulting in a constant length cycle. The other method, a more efficient one, uses one cycle length for the three movements and a shorter cycle when the third phase is eliminated. Our first example of such timing in Chicago was at the intersection of 35th St., Hoyne and Archer Aves. Hoyne Ave. carrying a relatively small amount of traffic is allowed to move only in alternate cycles. By the first method the total time cycle is kept constant at 52 seconds since this intersection is interconnected with that of Archer and Damen 850 ft. away, providing progressive movement in Archer Ave., a heavily traveled thoroughfare. See Fig. 2. Similar treatment will soon be effected at So. Chicago Ave., Yates and 87th St. to be coordinated with South Chicago and 89th St., two blocks away. Another case will be that of the intersection of Dayton St., Clybourn and North Ave. By the second method mentioned above the cycle will be shortened when Dayton St. is not given a movement. The reason being that there are two other nearby two-phase intersections all to be interconnected

and on account of the short intervening street distances the total time cycle is best held to a minimum.

Yet another type of timing might be used at a three-street intersection where two of the streets are relatively minor. In this case the major street can be given a movement after each of the other two streets, making in effect a four-phase cycle. While no example of such timing exists in Chicago as yet, obviously it has merit in a proper application.

Vehicle-Actuated Control

Occasionally an intersection adjacent to a railway grade crossing is to be signallized making it desirable or necessary to coordinate the stop and go signals with the railway gate operation. Several of such installations are functioning in the city. In general the result obtained is: (1) Immediate cessation of vehicular movement across the tracks upon the approach of a train; (2) The movement of traffic on the street paralleling the railway during the time that the gates are down; (3) An immediate return of "go" signals to the street which was interrupted, when the gates clear, in some cases giving additional time to the latter street to evacuate, followed by (4) the usual automatic signal operation until the next gate interruption.

Vehicle-actuated control equipment referred to above is a very efficient type of signal timing. The principle involved is that the time given to the movement of traffic should be dependent upon the amount of traffic immediately present and since the flow of vehicles is constantly varying, over short periods of time, the allotment periods should be variable by means of detectors which literally "feel" the presence of vehicles. Equipment on the market has been highly perfected and though more expensive, when used properly gives highly beneficial results. Chicago has at present 25 intersections so equipped, with an additional seven intersections on boundary line streets installed by the State Highway Department.

Providing Progressive Movement of Traffic

The modern trend in traffic signal development is toward inter-relation of signal timing to provide progressive movement of traffic. This should be done wherever it is practical to do so. We have made great progress toward that end in this city albeit there is much yet to be accomplished. Wherever a distinct advantage can be gained by the proximity of signaled intersections some form of progressive timing is instituted. Ultimately we shall probably see a comprehensive gridiron pattern of traffic signals at quarter mile intervals, all timed in definite relationship one with another. Such relationship may be maintained either by interconnecting cable or by the use of synchronous motors operated from a common source of electrical supply. We now have numerous

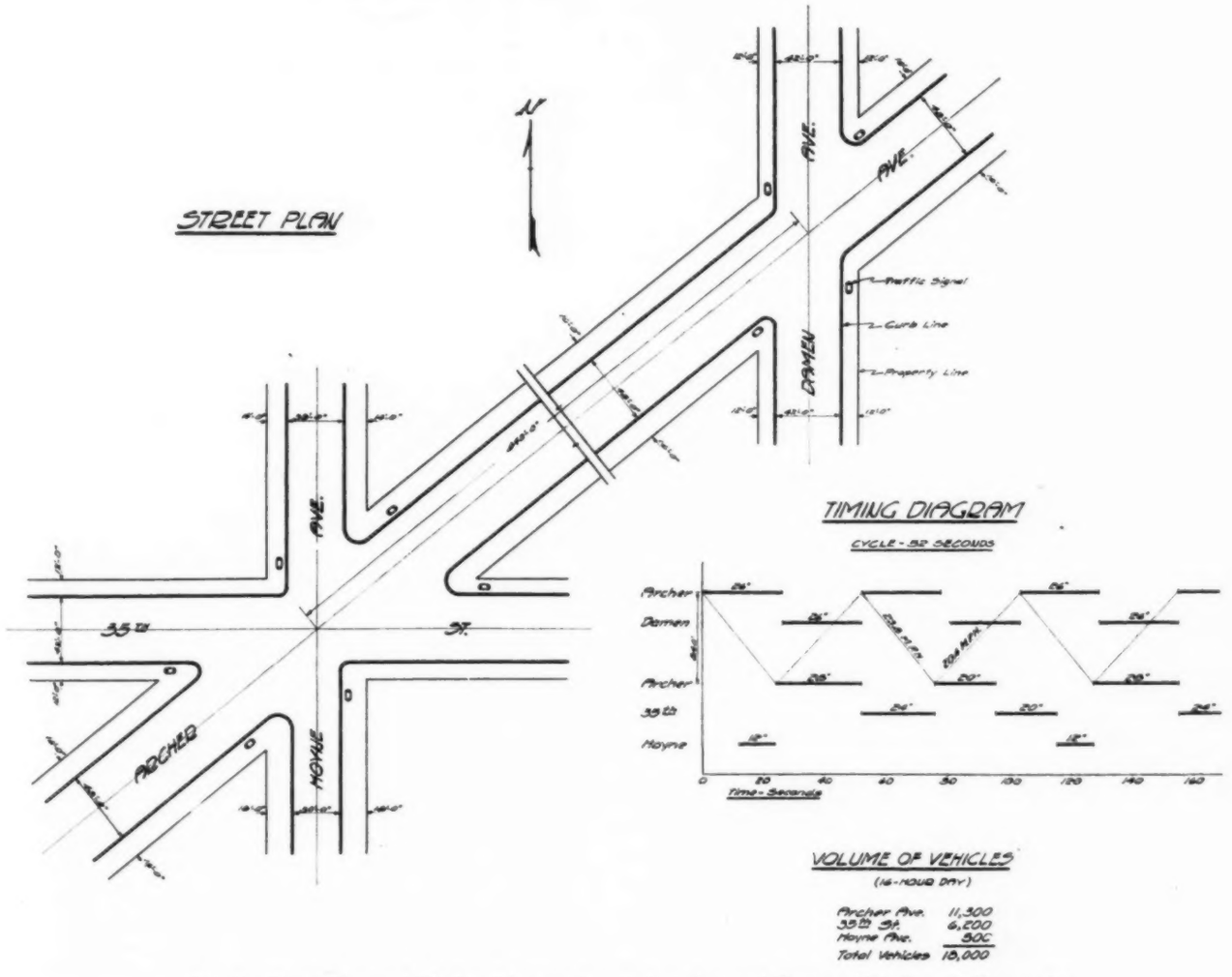

Fig. 2—Street Plan and Timing Diagram for Archer Ave. and Damen, 35th St. and Hoyne Ave.

progressive systems using each method of coordination and combinations of the two. There are 20 major progressive systems relating more than three intersections, and 71 short or minor systems involving two or three intersections. Examples of the former are (1) The loop system; (2) Michigan Ave. (now under Park District jurisdiction); (3) La Salle St.; (4) North Ashland Ave; (5) Foster Ave; (6) Cicero Ave., and (7) Central Ave. The loop system covering 71 intersections is operated from a master control board, located in the City Hall under the supervision of an operator. All other systems including Michigan Ave., are operated by a master control unit located at some point on the street.

The Michigan Ave. system is probably the most modern and complete progressive system in the entire country. Various flexibilities, such as cycle change, the favoring of rush direction traffic by changes of cycle split and relation between intersections are available from a central control point. Other refinements too numerous to mention make this an outstanding example of the results that can be accomplished by scientific analysis and treatment of the peculiar characteristics of a busy thoroughfare.

Further progress in signal development is evidenced in Chicago by the recent use of "Walk" indications for the exclusive benefit of pedestrians. Initial installation of WALK lenses was on Michigan Ave. However, at this writing three other intersections have been so equipped for purposes of investigation and study to determine the need for and the use given such indications under conditions found at the ordinary intersections.

Another refinement in signal operation, is the change from normal stop and go (red and green) indications to flashing (amber or red) indications during the night hours when traffic is in comparatively small volume. There are at present twenty-six intersections so equipped in the city which have proved conclusively the desirability of lessening delay, as well as the exposure to robbery, during hours when traffic is insufficient in volume to warrant the normal signal regulation.

Conclusion

The regulation of traffic by means of automatic signals, while it may reduce congestion and may afford greater protection for pedestrians, may also reduce average speeds, from origin to destination, to the extent where crest speeds between signals are excessively high. They may also cause motorists to choose devious routes of travel in avoidance of signals resulting in increased hazards at a greater number of unprotected intersections encountered. If delays from signals are minimized by scientific and individual treatment a greater degree of safety can be procured along major routes of travel with satisfactory overall speeds. Evidence of this can be found in the records of Michigan Ave., comparing the modern progressive system with the old system which it replaced. In the first ten months of operation there was a reduction of 27 per cent in total accidents and 40 per cent in accidents involving pedestrians. Average overall speeds were increased from 30 per cent to 45 per cent. Automatic signals are an aid in traffic ills if they are efficiently administered.

Statements from Mr. Sheets and Mr. Glover

To the Editor:

There recently appeared in the press a story regarding the hearing on a suit filed in the circuit court of Cook County for the appointment of a receiver for the American Concrete Expansion Joint Company of Chicago. In this story, the statement was made that 5 per cent of the corporation's stock was given to me, under an agreement signed on Sept. 28, 1932, while I was Chief Highway Engineer of Illinois, and that I still own the stock.

This statement is absolutely untrue. I have never signed such an agreement and know nothing about it. I have never owned any stock in American Concrete Expansion Joint Company of Chicago, and have never received any certificates for stock in that corporation or any dividends on any such stock, and I resent this unwarranted attack upon my business and professional integrity. Moreover, I have never owned any stock in, nor have I at any time in my career had any financial interest in any company which furnished materials or devices for highway construction, and I have never had any agreement, formal or informal, with anyone, under which I was to receive any stock or other financial interest in any such company.

For many years successful rural concrete pavements were built in Illinois under my direction as Chief Highway Engineer without any transverse joints. The only joint used was a longitudinal center joint, developed on the Bates Test Road in 1921, which was introduced to control irregular longitudinal cracking. We sealed this joint with bituminous material and created a center traffic line at the same time.

To determine whether this practice could be improved, we tried experimentally for a year or so prior to 1932, the installation of additional large 4-in. transverse expansion joints spaced about 1,000 ft. apart, but these were not entirely satisfactory.

Many other joint devices had been developed and proposed. To test the merit of these, the Illinois Division of Highways, in the summer of 1932, purchased a limited number of joints of each type that showed promise and I arranged for experimental installations to determine whether their performance was satisfactory enough to warrant a change in design policy.

After arrangements had been perfected for these experimental joint installations, a representative of the American Concrete Expansion Joint Company called at my office late in 1932 and showed me for the first time the joint offered by that company. Since it seemed to have as much merit as some of the other devices we were testing, I authorized, on Oct. 7, 1932, an experimental installation of these joints on 5,860 ft. of concrete road located on State Bond Issue Route No. 122, Section 127, Tazewell County, near Minier, Illinois. The joints for this experimental installation were purchased by the State, as were all others, and were subsequently installed early in November, 1932.

I made clear to the representatives of the American Concrete Expansion Joint Company and to all other producers that these were experimental installations of joints and that until tests, observation, and field performance had demonstrated their effectiveness, there would be no change in state road specifications.

On Jan. 15, 1933, I retired as Chief Highway Engineer and up to that date had received no reports on the results of the experimental installations of any of the

joints we were testing nor had I taken any action involving a change in joint specifications.

On Feb. 20, 1933, I opened, at 911 Ridgely Farmers Bank Building, Springfield, Ill., an office for the independent practice of consulting engineering and shortly thereafter sent our formal announcements.

About this time, Mr. James Jacobson, President of the American Concrete Expansion Joint Company, negotiated with me for some consulting service relating to the engineering development and practical application of the joints produced by that company. On Feb. 23, 1933, I wrote Mr. Jacobson outlining the conditions under which I would perform the service desired, stated my fee and, further, specified that in view of my professional engagements, I was not at liberty to link my name with the production or promotion of any commercial commodity and that this precluded my sponsoring any letters or technical articles relating to the product or making any appearance of a promotive nature. I further stated "However, I can ethically serve as your technical adviser in matters pertaining to the production and use of your construction joints with the express understanding that my name will not be used in the sales or promotion of your products."

This was agreed to, the technical work was performed by me and my fees for that work were paid in full by check and the amount was in harmony with the standards and practice of the engineering profession. The work was terminated on July 3, 1933, and I have performed no engineering or other service for that company since that time.

I reiterate I have never had any business interest in the American Concrete Expansion Joint Company and the only service performed for that organization was as an independent consultant, subsequent to my retirement as Chief Highway Engineer.

In view of the serious injury which has been done to me by the publication of these statements, I trust that your sense of fairness will lead you to give equal emphasis to the truth about the situation as herein stated.

FRANK T. SHEETS,
Consulting Engineer.

Chicago, Ill., April 15, 1937.

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To the Editor: There recently appeared in the press an article regarding a hearing on a suit filed in the Circuit Court of Cook County for the appointment of a receiver for the American Concrete Expansion Joint Company. According to the article it was disclosed at the hearing that State highway officials and former officials entrusted with the letting of highway construction contracts are officers and stockholders in the American Concrete Expansion Joint Company; that 1 per cent of the company's stock was given to me under an agreement signed September 28, 1932; that I still own this stock; that at that time I was an assistant to the Chief Highway Engineer; that today I am Engineer of Materials for the State Department of Public Works and Buildings, Division of Highways at Springfield.

The statement that I am charged with the letting of highway construction contracts and that I received 1 per cent of the stock of the American Concrete Expansion Joint Company under an agrement dated Sept. 28, 1932, and that I still own this stock is absolutely untrue and without foundation.

I did not then and do not now have any connection whatsoever with the letting of highway contracts. I wish to state emphatically that I never signed such an agreement and had no knowledge of it. I have never owned any stock in the American Concrete Expansion Joint Company, and have never received any certificates for stock in that company; neither have I received any dividends or payments of any kind or description from this company.

Furthermore, I never was and am not now in any way connected with this or any other concern furnishing materials for highway construction work.

At the time the expansion joint device manufactured by the American Concrete Expansion Joint Company was presented to the Division of Highways for consideration, I held the same position that I hold now, namely, Engineer of Materials in charge of the Bureau of Materials, and was not an assistant to the Chief Highway Engineer as stated in the article.

The expansion device presented by this company was investigated and tested in the same manner that any other material or device presented by any other concern is investigated and tested, and I have dealt with the company solely in my official capacity as Engineer of Materials in the same way that I deal with many other concerns furnishing many different kinds of materials and devices for highway work.

I resent this unwarranted attack upon my professional and business integrity, and in view of the injury to me which has resulted from the publication of this article, I trust that you will, in all sense of fairness, give equal emphasis to the facts concerning this matter as I have stated them herein.

V. L. GLOVER,
Engineer of Materials,
Division of Highways.

Springfield, Ill., April 15.

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Piling Requirements for Bridge Construction

The Bridge Division of the Ohio State Highway Department, in conjunction with the Engineering Experiment Station at Ohio State University at Columbus, O., has been making a study of the predetermination of piling requirements for bridge foundations. This research has consisted primarily of the development of equipment for the driving of rods by the application of a known force and measuring the resultant penetration. As a result of many comparisons this penetration is calibrated in relationship to the penetration of piling driven at the same site. As may be expected, it is found that this relationship varies widely with extreme variations in soil characteristics. In a paper presented at the last Purdue Road School J. R. Burkey, Chief Engineer of Bridges of the Ohio State Highway Department, stated that each year they were making better progress in interpreting this relationship and while the results may fall far short of perfection the advance estimates of piling lengths required, in general, are in much closer conformance to final construction than was possible before this study was begun.

Bulletin No. 90 of the Engineering Experiment Station at the university describes the manner in which these studies were made.

100 MILES OF ROAD TO SKIRT THE LOUISIANA GULF COAST PLANNED BY LOUISIANA RICE TRAIL AND LOUISIANA-TEXAS GULF COASTAL HIGHWAY ASSOCIATIONS.

ROAD BUILDERS

MAY, 1937 AMERICAN ROAD BUILDERS'

Charles M. Upham

Down the Road

By C. M. UPHAM

Engineer-Director, American Road Builders' Association

THE VALLEY OF DEATH

Cars to the right of him, cars to the left of him, cars all around him; into the valley of death rides the American motorist! Overstatement? Not in the least! Let me prove my point.

With the settlement of labor troubles all branches of the automobile industry will swing back into full assembly activity and resume its push for the biggest production year in the industry's history with the exception of 1929.

Estimates point to a 5,000,000 output for 1937 and the industry seriously expects to assemble approximately 1,750 cars and trucks during the second quarter of this year to make an aggregate of close to 3,000,000 units for the first six months. Leading executives predict that the present year can easily become the best year since the beginning of mass production of motorcars.

This is a very gratifying picture from a purely industrial standpoint. American business can stand increased productiveness in the building of automobiles and trucks. But what of the roads over which they must travel? That, to be perfectly candid, is a very black and foreboding picture! Highways have not kept pace with the building of motorcars. With few exceptions, the nation's roads have not been built to safely carry today's greatly increased and speeded up traffic. Imagine, then, the hazards of tomorrow's highways when the cars and trucks produced in 1937 are added to those already on the road, if something immediate and definite is not done by the respective states to modernize their antiquated highways. New roads must be constructed and safety must be built into them. Safety must also be built into the old roads as they are rehabilitated.

Think with me of the nation's highway system as a gigantic tub and think of the motor vehicles as a continuous stream of water directed into that tub. Picture the water speedily rising to the overflow point and you have a striking example of the country's need for more good and safe roads. Unless the "tub" is replaced by a bigger one the flow of "water" cannot be handled. That is very clear, isn't it? So clear that you are positive the members of certain state legislatures must also realize its truth. Yet the practice of diverting highway funds goes on as those same supposedly intelligent legislators continue to pass laws misappropriating highway-tax money to uses disassociated with the building and upkeep of good and safe roads. These unconcerned individuals have got to be made to realize that the construction and maintenance of highways must keep pace with the building of automobiles and trucks.

How can the state and national highways be made safe for tomorrow's trebled traffic if the money collected today for that purpose is spent on other things?

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PROGRESS IN THE PAMPAS

According to recent news from Argentina, one of two highways now in the process of active construction in that country will become the route of the Argentine section of the Pan-American Highway which, when completed, will stretch 11,850 miles from Buenos Aires to Washington. One of these roads will cross the north of Argentina, thence through Bolivia, and is to consist of 930 miles of paving and 375 miles of allweather surfacing that can be traveled throughout the year. The other will traverse the country west from Buenos Aires, crossing the Andes into Chile through the Uspallata Pass, and thence to Santiago, and northward to the Pacific Coast. Full speed ahead for Argentina and its contribution to the Pan-American Highway!

NEW PUBLICITY DIRECTOR APPOINTED BY ROAD BUILDERS

Robert E. Harper of New Orleans, Louisiana, has been appointed the new director of publicity of the American Road Builders' Association, according to an announcement from the office of Charles M. Upham, engineer-director of the organization.

His immediate background is one of experience as proofreader, reporter, sports writer and copyreader on four of Lousiana's leading newspapers, the New Orleans "Times-Picayune," the Baton Rouge "States Times," the Lake Charles "American Press" and the New Orleans "Item-Tribune." In 1935 he wrote a column called "Uptown, Downtown and Back o' Town" for the "New Orleanian," a class publication.

Mr. Harper came to the Road Builders from the New Orleans office of Shell Petroleum Corporation, where he had for nearly two years been engaged in that company's sales promotional and advertising activities in its Southern division. In that capacity he edited "Shellight," one of the corporation's house organs.

Robert E. Harper

In addition to his newspaper and oil company services he assisted several of the leading busines men of his native city in a free-lance advertising capacity. His endeavors in Washington will be to nationally and internationally publicize the activities of the A. R. B. A. and its affiliate members through articles, cartoons and direct-mail literature and he will serve as editor and staff artist for the "Road Builders' News," official publication of the Association, the first copy of which was issued during the early part of this month.

Resume'

AUTO ACCIDENT DEATHS IN CALIFORNIA REACHED ALL-TIME HIGH IN 1936 WITH THE REGISTRATION OF 3,132 FATALITIES.

ASSOCIATION—WASHINGTON, D. C. MAY, 1937

HIGHWAY SAFETY LEADERS TO MEET IN WASHINGTON

Fifty of the nation's leading highway engineers and safety experts and enthusiasts will converge in Washington, D. C., May 27, for the meeting of the Committee on Safe Highways of the American Road Builders' Association.

The members of this committee have been nationally prominent in spreading the current countrywide drive to reduce the staggering number of fatalities and permanent disabilities caused by motor-vehicle highway accidents.

Under the chairmanship of Dr. H. E. Tabler, chairman of Maryland's State Roads Commission, the A. R. B. A. Committee on Safe Highways represents nearly every state in the Union. Governors of 34 states, comprising a special honorary committee, are sponsors of the humane activities of this safety group.

Besides the honorary gubernatorial contingent, this highway safety committee has the backing of an advisory board composed of representatives from four federal agencies and 15 national associaciations and professional societies that are interested in highway safety.

Dr. H. E. Tabler

Nine reports dealing with highway safety from the standpoint of design and construction are to be presented for consideration and final decision at the May meeting as the Committee on Safe Highways of the American Road Builders' Association takes definite steps toward putting into operation a practical procedure to cut down the nation's highway death toll in 1937 and in the years to come.

COMMITTEE ON ROADS

Committee on roads of the House of Representatives, Washington, D. C. Seated, left to right, Honorables William M. Whittington, Mississippi; Wilburn Cartwright, Oklahoma, chairman; Jesse P. Wolcott, Michigan, and James W. Mott, Oregon. Standing, left to right, Honorables Nat Patton, Texas; John L. McClellan, Arkansas; Robert T. Secrest, Ohio; Jennings Randolph, West Virginia; Lewis L. Boyer, Illinois; John J. Sparkman, Alabama; Bernard J. Gehrmann, Wisconsin; William S. Jacobsen, Iowa; Mr. Wainwright Bridges, Oklahoma, clerk; Honorables Karl Stefan, Nebraska, and Cassius C. Dowell, Iowa.

ROAD BUILDERS SCHEDULE ANNUAL MEETING AT WILLARD HOTEL, WASHINGTON, MAY 26-28

"The May meeting this year is going to be outstanding in its interest to the individual members present," said Charles M. Upham, engineer-director, in issuing the call to the 35th annual three-day May meeting of the American Road Builders' Association which will be held at the Willard Hotel, Wednesday, Thursday and Friday, May 26, 27 and 28, with approximately 300 members in attendance.

Officers, directors, divison heads, educators, manufacturers, highway contractors and engineers, state, municipal and county officials, and other interested individual members representing their particular phase of the highway industry and profession will be on hand to take part in the diversified three-day program.

Wednesday, May 26, will witness sessions of the outgoing and incoming boards of directors, the entire organization, the joint exhibit committee, the manufacturers' division and its board of directors, the planning and educational divisions and their respective committees.

Thursday, May 27, will be high-lighted by meetings of the committees on Airport and Roadway Drainage, Gas-Tax Diversion, Legislation, Organization and Extension, Platform for American Highway Development, Resolutions, Safe Highways, Stabilized Road Construction, Development of Highway Construction Equipment, County Highways and Municipal officials' divisions and their respective boards, and the Highway Contractors' division and its board of directors and committees.

On the third and last day, Friday, May 28, the program committee will hold its meeting in the morning and the golf enthusiasts present will participate that afternoon in a round or two over the sporty links of the Congressional Country Club, bringing the 35th annual May meeting to a pleasant conclusion.

EFFECT OF DEPRESSION ON ENGINEERING PROFESSION

A SURVEY of the engineering profession was undertaken in May, 1935, by the U. S. Bureau of Labor Statistics, at the request of American Engineering Council, to determine the extent of the depression's impact upon professional engineers. A questionnaire was mailed to 173,151 engineers and from the 52,589 replies a report was prepared by A. F. Hinrichs, Chief Economist, and Andrew Fraser, Jr., of the Bureau's Division of Wages, Hours and Working Conditions. The report appears in the January, 1937, issue of the Monthly Labor Review, from which the following notes are taken.

As a result of the survey it may now be said that at the end of 1932 more than one-tenth of the engineers were simultaneously unemployed, that at one time or another between the beginning of 1930 and the end of 1934 more than one-third of the engineers had some period of unemployment, and that half of those who became unemployed were out of work for more than a year.

From the 52,589 reports from professional engineers throughout the country, the following summary analysis of unemployment, including work relief and direct relief, may be presented:

1. Between the end of 1929 and 1932, the percentage of engineers who were unemployed increased from 0.7 to 10.9. At the end of 1934 the percentage was 8.9.

2. At no time was direct relief extensive among engineers, but the development of work-relief programs after 1932 became an important factor. Although 10.9 per cent of all engineers reporting were unemployed on December 31, 1932, less than one-fifteenth of those unemployed were on work relief. On Dec. 31, 1934, 4.0 per cent of all engineers reporting had work relief, i.e., almost half of the total number of engineers unemployed at that time.

3. The largest number unemployed at any one time was about 11 per cent of the total, but more than a third of the engineers had some period of unemployment within the 5 years, 1930 to 1934.

4. Among those who became unemployed at some time during these five years, half were out of employment (except as they found work relief) for more than a year.

5. This experience with unemployment was common to all professional classes of engineers. In 1932 unemployment ranged from 10.1 per cent among chemical and ceramic engineers to 11.6 per cent among electrical engineers. In 1934 approximately 8 per cent of the electrical, mechanical, and industrial and of the mining and metallurgical engineers were unemployed. The percentage of unemployment dropped most among chemical engineers, of whom 6.8 per cent were unemployed in December, 1934. There was a slight increase in unemployment among civil engineers from 1932 to 1934.

6. The most marked differences as regards unemployment are those found among the various age groups. The greatest frequency of unemployment was among those who attempted to enter the profession after 1929. Approximately half of them were unemployed at one time or another from 1930 to 1934. Older engineers, who were already professionally established prior to 1929, were less frequently unemployed, though even among those with 20 or more years of experience one-quarter had some unemployment.

7. When the older engineers became unemployed, however, unemployment lasted longer than it did with the younger engineers. Thus, the median period of unemployment for engineers graduating in 1925-29 was 12.1 months, whereas the median for those graduating prior to 1905 was 23.1 months.

8. The effect of this longer period of unemployment among older engineers was cumulatively to produce a higher percentage of unemployment among older engineers than among younger engineers. Thus, in December, 1934, 11.5 per cent of the engineers 53 years of age or more were unemployed, in contrast to an average of 7.3 per cent of the younger engineers who were exposed for the same period to the risk of possible unemployment.

9. The type of education the professional engineer had received did effect variations in both the incidence and severity of unemployment. These factors were very much less for postgraduates than for engineers with other types of education. But as between engineers with first degrees in engineering and those whose college course was incomplete or who had attended non-collegiate technical schools, the differentials were very slight.

10. The influence of regional location on unemployment was practically negligible, whether considered from the point of view of differentials in incidence or of severity of unemployment.

TABLE I—PER CENT OF ENGINEERS IN EACH PROFESSIONAL CLASS UNEMPLOYED[1] ON DEC. 31, 1929, 1932, AND 1934

Professional Class[2]	Per Cent Unemployed on Dec. 31— 1929	1932	1934
All engineers	0.7	10.9	8.9
Chemical and ceramic engineers	.5	10.1	6.8
Civil, agricultural, and architectural engineers	.7	10.5	10.8
Electrical engineers	.8	11.6	8.0
Mechanical and industrial engineers	.7	11.3	7.5
Mining and metallurgical engineers	2.1	10.9	8.3

[1]Including those on direct relief and work relief.
[2]The total numbers of engineers in the various classes reporting unemployment is not shown in this article but will become available in a statistical appendix. While the percentage of unemployment was one-fifth less in 1934 than in 1932, the number of engineers reporting employment in 1934 was 48,124 as against 40,721 in 1932, due to the entrance of new persons into the profession. The number reporting unemployment dropped from 4,448 in 1932 to 4,288 in 1934, a decline of less than 4 per cent. Due to the overrepresentation of recent college graduates in the sample and the high percentage of unemployment among them, the total number reporting unemployment in 1934 should not be compared with the total number reporting unemployment in 1932.

Constitutional Amendments to Stop Diversion

The Indiana Legislature passed a Joint Resolution to amend the constitution so that highway revenues—including registration fees, licenses, gasoline taxes and all other highway taxes—be used for highway purposes and shall not be diverted by transfer of fund, or otherwise, to any other purpose whatsoever.

Constitutional amendment proposals have been introduced in the following states: Delaware, Georgia, Idaho, Iowa, Maryland, New Jersey, North Carolina, Pennsylvania, South Dakota, Utah, Washington.

The only two legislatures which have passed the constitutional amendment proposals up to the present time are: Alabama and Indiana.

PROCESSES IN MANUFACTURE OF PORTLAND CEMENT

The First of a Series of Articles Concerning Cements

By EDWARD E. BAUER

Assistant Professor, Civil Engineering, University of Illinois

IN 1824, in Leeds, England, a bricklayer by the name of Joseph Aspdin, working in his own home, took a quantity of limestone, such as was used in repairing roads, calcined it, mixed it with some clay, calcined the mixture, and then powdered the resulting compound. Today the same raw materials, limestone and clay, are prepared, burned, and the resultant clinker ground to a high degree of fineness, in a process that is highly mechanical, yet scientifically refined. Aspdin called his material portland cement because the hardened product which resulted from a mixture of it and water resembled a famous building stone of that day which was found on the Isle of Portland.

Many individuals have played a part in the development of portland cement, and the history of that development is very interesting. One man, Isaac C. Johnson,

View in Limestone Quarry, Which Is the Source of the Calcareous Raw Material.

of England, appears now to be the real discoverer, having come much nearer to our present day practice of manufacture than did Aspdin.[1]

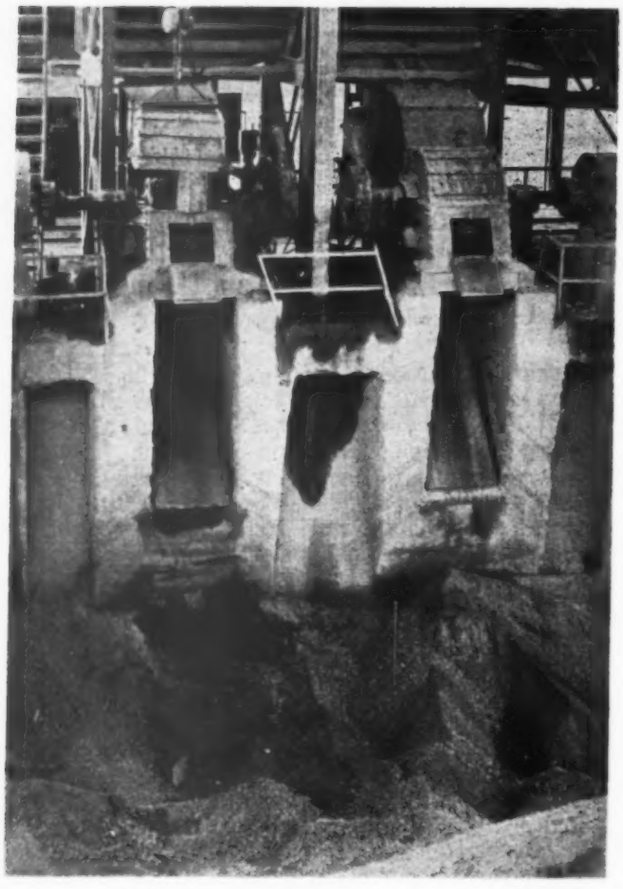
The first portland cement manufactured in this country was made in 1872 at Copley, Penn., in mills started by David O. Saylor. Soon afterward, other plants were started at Egypt, Penn., in 1882, by Robert W. Lesley; at Oregon City, Ore., in 1884; at Kalamazoo, Mich., in 1885; in Rosendale district, New York, in 1876-77; and at Rockland, Me., in 1879. Some of Saylor's cement was used in the construction of the Ead's Jetties at the South Pass mouth of the Mississippi River in 1875-79. Table I indicates the growth of the industry in the United States.

Manufacture

Portland cement is the product obtained by finely pulverizing clinker which is produced by heating to the point of fusion a mixture of argillaceous and calcareous materials, with a small amount of gypsum added during the grinding of the clinker for the purpose of controlling the rate of setting. An argillaceous material is defined as a clayey material and a calcareous material is a lime bearing material. Chemically the clayey material is an aluminum silicate and the calcareous material is a calcium carbonate, but neither of them exist without some impurities being present. The principal impurity in both is iron. A discussion of the chemical compounds in cements will be given in the second article of the series.

Raw Materials—The raw materials used most generally in the manufacture of cement are limestone and shale or clay. Other combinations are blast-furnace slag and limestone; cement rock and limestone; and shale or clay and marl. Cement rock is a limestone, found principally in Pennsylvania, which contains more than 50 per cent clay. Marl is a soft deposit of clay and calcium carbonate found in the bottoms of shallow lakes, swamps, or extinct fresh-water basins. The number of plants using marl today is very small.

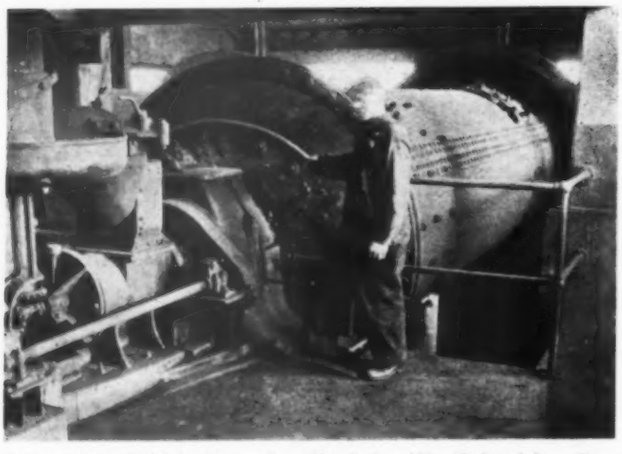
Giant Gyratory Crusher Used in Breaking Up Large Pieces of Stone.



Hammer Mills Used in Second Stage of Grinding Raw Materials.

Not all deposits of clay or limestone are alike, nor are they uniform within the deposit and before any of these materials may be used, they must be analyzed chemically to determine their composition, since it is highly important that the finished product have the proper chemical composition. The chemist therefore plays a very important role in the production of cement.

Two Processes of Manufacture—There are two general processes of manufacture known as the dry process and the wet process. In the former the raw materials are dried in their preparation for burning, while in the wet process they are mixed with water to form what is known as a slurry. The dry process has been in continuous use since the beginning of manufacture while the wet process dates from 1915.[2] The wet process was introduced with the idea of securing a more uniform mixture of the raw materials, and many manufacturers have adopted it. Not all will agree, however, that a satisfactory mixing of the raw materials can not be secured with the dry process and these producers have introduced and developed special equipment for the "blending" of the limestone and clay.

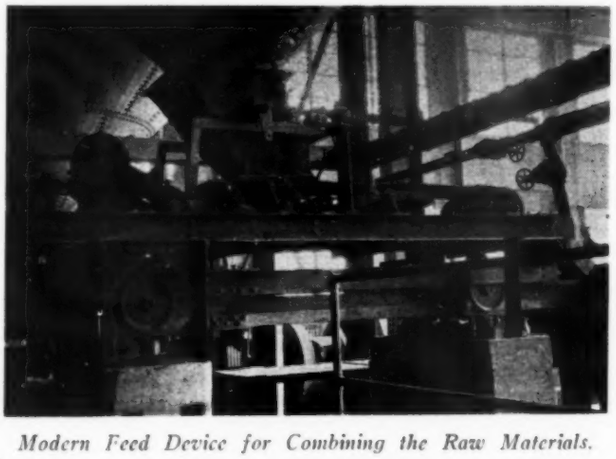


Tube Mill, Which May Be Used in (1) Pulverizing Raw Materials, (2) Grinding Coal for Burning, or (3) Grinding the Clinker.

Dry Process—The hard materials as they come from the quarry must be crushed so that all pieces will pass a 2- or 3-in. screen, large gyratory crushers being used generally. The materials are then dried in large hollow steel cylinders, 50 ft. in length and 5 ft. in diameter, waste heat being frequently used.

For proper burning about 85 per cent of the raw mixture should pass a No. 200 sieve, which has 200 openings per linear inch or 40,000 per square inch. The grinding is accomplished in two stages known as preliminary and final grinding. Preliminary grinding is usually done in a preliminator, which is a ball mill having a diameter of 8 ft. and a length of 5½ ft. The grinding is accomplished by the action of 6 to 8 tons of steel balls, 2½ to 5 in. in diameter as the drum revolves. After the preliminary grinding the materials should pass a No. 20 sieve.

At this point the argillaceous and calcareous materials are combined, the proportions being based on chemical analysis of each. Final grinding is usually done in a tube mill which is 22 ft. in length and 5 or 6 ft. in diameter. The charge in the tube mill is about 15 tons of flint stones or steel balls. As the two materials are fed into the tube mill automatic scales control the amount of each entering. The material as it leaves the mill has a fineness equivalent to 90 per cent passing the No. 200 sieve.



Modern Feed Device for Combining the Raw Materials.

Before the raw mixture is introduced into the kiln for burning chemical analyses are made and if the mixture is not of the proper composition, the contents of a number of bins of different compositions are mixed or blended together, the process being repeated until the desired composition is secured.

Wet Process—In the wet process the limestone and shale or clay are reduced in size so that all will pass a No. 20 sieve, without being dried. They are then mixed with water to form a slurry and ground in a tube mill to the same degree of fineness as in the dry process. The slurry is run into tanks where it must be

agitated continuously to prevent the solids from settling out. Chemical analyses are made and the contents of several slurry tanks of different analyses combined and recombined until the proper chemical composition results.

In the early days of the wet process, the slurry was pumped directly into the kiln but present practice is to remove the water by use of waste heat from the kiln, in specially developed driers.

Burning—The first kilns used were of the vertical type similar to those used in the production of iron. The rotary kiln was first used in the United States in 1886, it being a cylinder 24 ft. in length and 12 ft. in diameter. The second kiln, put in use in 1889, was 25 ft. in length and 5 ft. in diameter. In 1909 Thomas Edison was granted a patent for the use of kilns 150 ft. and greater in length, and it was with the development of longer kilns that the possibilities of quantity production were opened up.[1] Today kilns vary in length from 150 to 374 ft. and from 5 to 12 ft. in diameter.

The rotary kiln is a steel cylinder lined with fire brick. It is supported at various points along its length on rollers. The inclination with the horizontal is ½ to ¾ in. per foot. The speed of rotation is about ¾ revolution per minute.

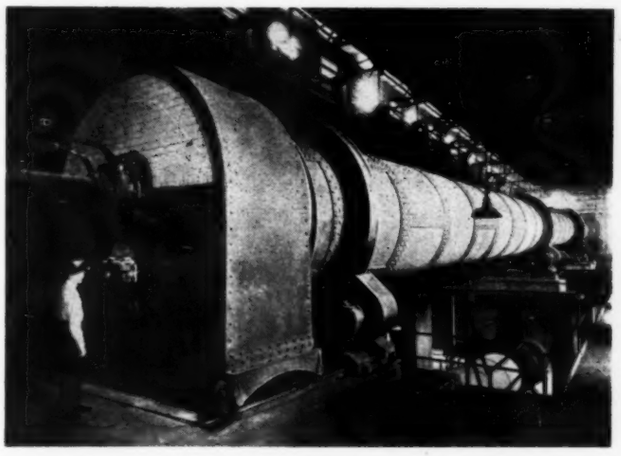
Fuel Oil Blower.

The fuel, which may be powdered coal, gas or oil, is introduced at the lower end while the prepared raw materials are put in at the upper end. The raw materials gradually work themselves down through the long kiln in about an hour. They are heated to a temperature of 2,500 to 3,000° F. at which temperature a clinker of a black or a greenish black color is formed. It has a vitreous luster and is quite hard.

The output of a rotary kiln varies from 500 to 3,000 bbl. per day, depending upon its size. In producing a 376-lb. barrel of cement about 175 lb. of coal are burned and 600 to 700 lb. of raw materials are used.

Grinding the Clinker—The clinker, which results from the burning, is ground in much the same manner as the raw materials. Recent developments in grinding equipment permit finer grinding and do it in one operation instead of two.

During the grinding, a small amount, usually 2 per cent, of gypsum ($CaSO_4 + 2H_2O$) or plaster of Paris



Long Horizontal Rotary Kiln Used in Burning the Raw Materials into Clinker. Fuel Is Fed into Kiln Through Pipe Above the Man's Head.

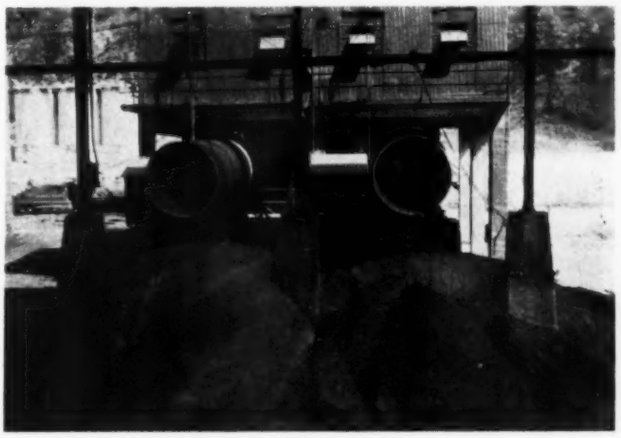
($CaSO_4 + \frac{1}{2}H_2O$), is added to retard the rate of setting of the cement. During the setting period, the cement gradually loses its ability to be remolded or reshaped. If the gypsum were not added the cement would set too rapidly for practical use.

Cements developing strength rapidly in the early ages are often spoken of incorrectly as "quick-setting" cements. If they were really "quick-setting," they could not be used in construction.

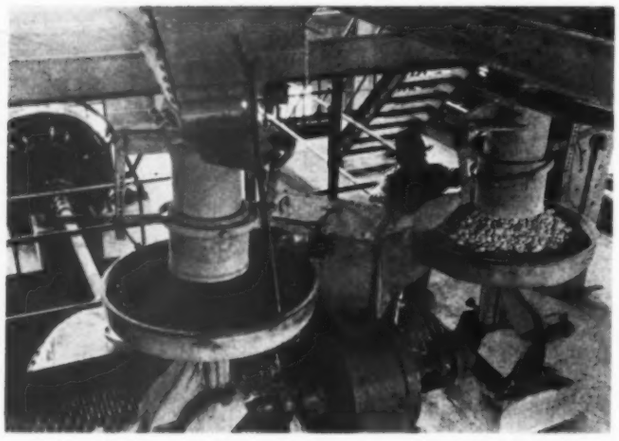
The present A. S. T. M. specification (Designation C 9-30) requires that not more than 22 per cent may be retained on the No. 200 sieve, but manufacturers are actually grinding their cements fine enough so that not more than 10 per cent, and often not more than 2 per cent is retained.

Bagging—In the early days, cement was shipped in wooden barrels containing 376 pounds net. Today most of the cement is shipped in sacks, each containing one-fourth barrel or 94 lbs. net. The cotton cloth sack was used exclusively until a few years ago when the multiple-walled paper sack was introduced. Cement in paper sacks costs the purchaser a small amount more than that in cloth, provided the cloth sack is returned. The paper sack offers better protection against moisture, and when it is emptied none of the cement can remain in the sack as is the case of the cloth sack.

An interesting detail is the filling of the sacks after the top has been wired shut. A special slot is made in the bottom of the bag for filling purposes. When the



Clinker Cooler and Storage. Heat from the Clinker Is Recovered and Used Again.



Clinker and Gypsum Are Fed Automatically into Grinding Equipment. View Shows Table Feeders.

cement is in the bag, the weight of the cement closes the valve. Automatic scales are usd in filling the bags to control the amount placed in each bag.

TABLE 1. THE PORTLAND CEMENT INDUSTRY IN THE UNITED STATES

Year	Production, Barrels	Number of Producing Plants	Average Factory Price	Per Capita Consumption
1880	42,000	...	$3.00	...
1890	335,500	16	2.09	...
1900	8,482,,202	50	1.09	...
1910	76,549,951	111	0.891	...
1915	85,914,907	106	0.86	0.83
1920	100,023,245	117	2.02	0.87
1928	176,298,846	156	1.57	1.45
1930	161,197,228	163	1.44	1.29
1931	125,429,071	165	1.11	1.06
1932	76,740,945	166	1.01	0.67
1933	63,473,189	166	1.33	0.50
1934	77,682,000	166	1.52	0.62

Figures from U. S. Geological Survey and U. S. Bureau of Mines, as published in the "Cement and Concrete Reference Book," 1935, of the Portland Cement Association.

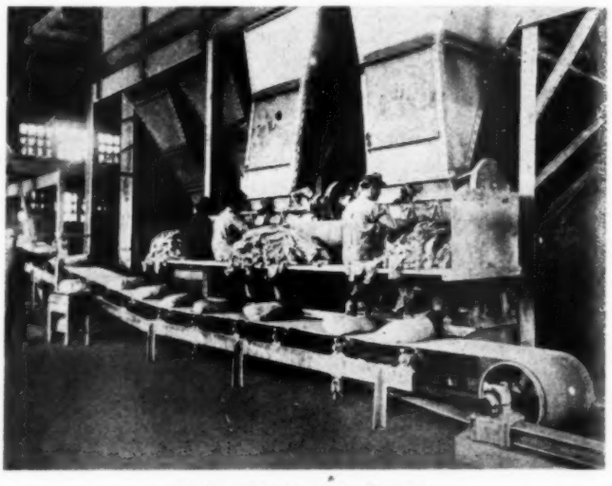
Cement is also shipped in bulk, it being most economical on large jobs when special handling equipment is justified. By 1929, weighing equipment for aggregates had become well enough developed to be used fairly generally. Since the same scales could be used to weigh the cement, use of bulk cement became possible. Special pumping equipment also had to be developed for unloading the cars and handling from the storage bins. In 1934 approximately 23 per cent of all cement shipped in the United States was shipped in bulk.

Production in the United States—Production of Portland cement in the United States increased from 42,000 bbls. in 1880 to a peak of 176 million bbls. in 1928. The low point in production during the depression was reached in 1933 when only 63 million barrels were made. In 1934 there were 166 producing plants in the United States.

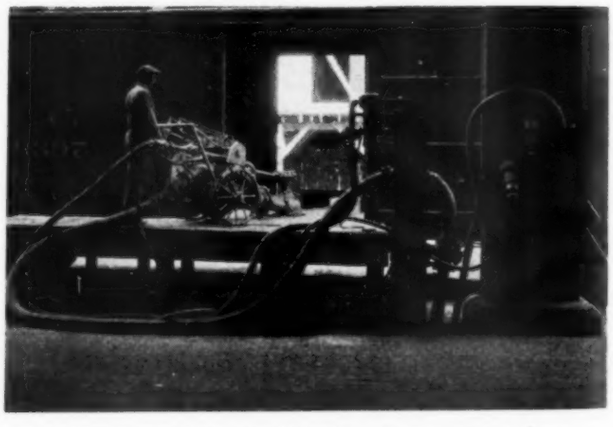
There was a general decline in the factory price of cement from 1900 to 1915, ($1.09 to $0.86 per barrel); then a rather sudden rise to $2.02 in 1920, followed by a steady decline until 1932, when it reached $1.01. Since then the price has been advancing, having reached $1.52 in 1934.

Acknowledgment.—The writer is indebted to the Portland Cement Association for the pictures included in this article. Also, for some of the information.

Battery of Tube Mills Used in Grinding the Clinker.



Filling Sacks with Cement.



Portable Pump Used in Unloading Bulk Cement from a Railroad Car.

FOOT NOTES

[1]Lesley, *History of the Portland Cement Industry in the United States* (1924). See also Davis *One Hundred Years of Portland Cement* for interesting historical data.

[2]Roberts, *"The Pioneer Wet Process Cement Plant on the North American Continent,"* *Pit and Quarry*, Vol. 11, No. 2, pp. 39ff, Oct. 15, 1925.

▼

MINNESOTA ROAD CROSSINGS REDUCED NEARLY 50 PER CENT—Minnesota's highway grade crossings, menaces to life and property that numbered 1,282 in 1921, had been cut to 649 at the end of 1936, and will be reduced at least 15 more in 1937.

METHODS OF SUBGRADE DRAINAGE

By H. E. COTTON
Drainage Engineer,
Armco Culvert Manufacturers' Association

THE cry is continually heard from engineers that good subdrainage costs too much. If the entire length of each mile of road needed subdrainage, the cost per mile would become a major item, but such is not the case. Generally speaking, our highway breakups, which can be attributed to excess ground water, are not continuous but occur in spots of varying lengths. A mile of road may have from one to a half dozen wet spots which are the weak links in that otherwise good road. Good drainage is not only worth the price but it is cheaper than no drainage in the long run, and is often cheaper than a single annual spring patching.

When subdrainage is needed there is nothing which will satisfactorily substitute for it. The best that can be obtained is the least that should be considered.

The General Problem of Subdrainage

Wherever free ground water exists to cause damage to the surface or to structures, it should be removed. Before the drainage system is designed, a thorough inspection should be made for location and depth of free water zones. Also in some cases soil characteristics should be studied. Such investigations are the only basis upon which location and depth of drains and their proper construction can intelligently be made.

Generally speaking, we have been guessing at the underground conditions. Therefore, our drainage installations have had a more or less haphazard degree of success. In fact, failures have been so numerous that many engineers have serious doubts as to the value of drains.

Investigations made during the wet season or soon after are advisable because the worst condition can then be seen. Free ground water may not exist during a long dry season but may be in abundance at other times.

Along our highways, free ground water can be seen in the shape of springs and seepage flowing from the face of cut banks. Free water can be detected in the soil when making test holes with the soil auger. The upper soil may be very wet with capillary water but no water can be seen on the sample. When the auger reaches the free water zone, water can be seen on the soil sample and water generally shows in the auger hole. Free water can be removed from the soil by drains, while capillary water cannot.

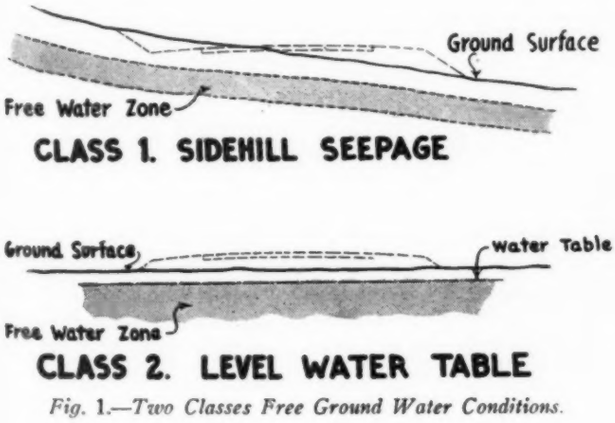


Fig. 1.—Two Classes Free Ground Water Conditions.

Ledge rock and other such conditions complicate the problem not only in making the installation but in making investigations to locate the water. Regardless of the difficulties and the expense of the investigations, the location and depth of drains should not be guessed at.

Free Ground Water Conditions

From the standpoint of subdrainage free ground water conditions may be divided into two classes (Fig. 1). This arbitrary division is made because subdrainage must be handled differently for each class.

Class I—The sidehill seepage condition.

This condition is found in slightly rolling, hilly and mountainous country. Probably more than 90 per cent of the surface of the U. S. A. can be classed under one of these headings. Free water zones are, in general, approximately parallel to the original ground surface and therefore most of these zones have a slope and may be termed "sidehill seepage zones."

Sidehill seepage zones very often function under a head. This is illustrated by the rise of water above the top of the free water zone when test holes or wells tap such zones.

Class II—The level water table conditions.

This condition is found in level country and particularly in swamp sections.

The free water has little or no lateral flow, but the water table may rise or fall during wet and dry seasons.

Capillary water may rise from both classes of conditions to cause subgrade trouble.

The sidehill seepage condition is the one most easily drained because outlets are generally available for drains of the needed depth. The problem is to intercept the water before it enters the roadway area and requires proper location and depth of drains to insure that all damaging water is shut off.

The problem in the level water table class is to lower the water table below the effective capillary rise limit.

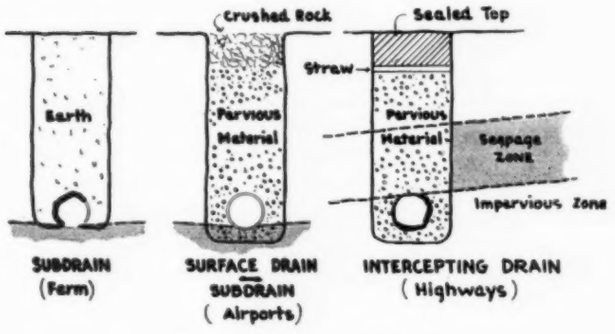


Fig. 2.—Kinds of Subdrains.

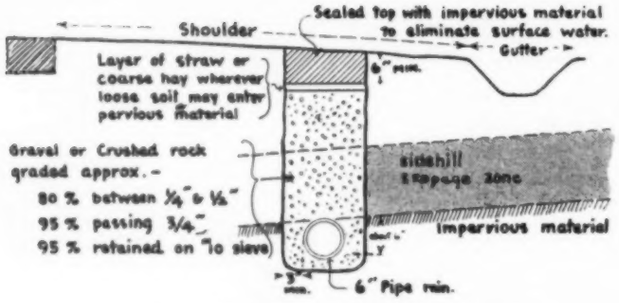

Shoulder
Sealed top with impervious material to eliminate surface water.
Gutter
Layer of straw or coarse hay wherever loose soil may enter pervious material
6" min.
Gravel or Crushed rock graded approx.—
80 % between ¼" & ½"
95 % passing ¾"
95 % retained on #10 sieve
sidehill seepage zone
Impervious material
3" min.
6" Pipe min.

Fig. 3.—Intercepting Drain (Sidedrain) Highways.

The effective capillary rise (a sufficient amount of water raised to cause damage) for each soil class has not yet been definitely established by our soil scientists, but for the usual soil it is said that drains 5 to 6 ft. below the road surface will be effective. The difficulty in successfully draining the level water table condition is that outlets for deep drains are seldom available.

Kinds of Drains

Present day subdrains may be divided into three classes according to their construction and use, as shown in Fig. 2.

1. The farm type subdrain has been used for half a century. It consists of a pipe in the bottom of an excavated trench which is backfilled with the excavated material. Its purpose is to lower the water table but not so low that capillary water will not reach the plant root zone.
2. The airport type of subdrain has in many cases been constructed as a combination surface drain and subdrain. The principal difference between this and the farm subdrain is that pervious material (gravel or crushed rock) has been used as a backfill. This has been found necessary to insure a quick runoff. When the problem is to remove surface water, the pervious material has been carried up to the surface.
3. The highway type of subdrain is essentially of the intercepting type. Like the airport drain, pervious backfill is used but it is generally advisable to seal the top against the entrance of surface water.

There are many modifications of these three kinds of drains and in fact every drain should be constructed to suit the conditions. Also, because of their importance, especially on high-class highways, every precaution should be taken to obtain the maximum efficiency and the longest life possible. For example in Fig. 3, certain refinements are suggested for the intercepting drain type which experience has shown to be advisable.

The Highway Intercepting Drain

The three most important features suggested for the intercepting drain and shown in Fig. 3 are:

1. Drain placed below the seepage zone and into the impervious zone. (Some exceptions to this rule.)
2. A finely graded pervious backfill.
3. A sealed top.

The purpose of the intercepting drain is, as the term implies, to stop and collect the lateral flow of water. The hydraulic principle employed here is that water follows the line of least resistance. The water drops vertically in the pervious backfill (gravel or crushed rock) to the bottom of the trench and then enters the pipe because that is the line of least resistance. To insure complete interception and collection the drain pipe should be placed into the impervious zone. The placing of pervious material under the pipe is advisable with soft bottom trenches where muck or runny material may tend to enter the pipe or to plug the openings. In no case should the aim be to establish a subdrain under the drain pipe. For extreme cases of quicksand or similar conditions, the placing of straw or coarse hay under and possibly around the pipe is advisable. In some sections of the West, tumble weeds have been used instead of straw. The life of the straw is probably not long measured in years, but will suffice until conditions are stabilized.

A comparatively finely graded pervious backfill, approximately as suggested in Fig. 3, is advisable for two principal reasons. In some instances, especially in airport drains where surface water enters at the top in considerable volume, there is a tendency to cause erosion on the side of the trench and the washing of the soil to the zone around the pipe. The finely graded pervious backfill lessens the vertical velocity of the water and therefore reduces such erosion. The cost of such backfill is usually less than that of 1-in. to 3-ins. screened gravel or crushed rock, which has been customarily specified. Very often bankrun gravel is available which approaches the suggested specification. Also in many localities such material is waste screenings from road construction materials.

The engineer's conception of the need for coarse backfill materials is handed down from the so-called French-drain installation where no pipe is used and lateral flow is dependent upon large voids. Airport construction and tests have proved that the finely graded material has more than ample downward carrying capacity. The drain pipe takes care of lateral flow in a much more efficient manner than any French drain.

The third important precaution suggested in Fig. 3, is that of a sealed top to prevent the entrance of surface water which may carry silt and sand and thus plug up the pervious backfill. The location of the drain shown in Fig. 3, is in the shoulder and not in the gutter, only for the reason that sealing may be more difficult in the latter location. The material used for sealing may be of clay or an artificial mixture in which asphalt or other materials are used to obtain imperviousness. If a material is used which may filter down into the gravel backfill, a layer of straw or coarse hay is advisable. On ordinary highway construction, it is advisable to remove surface water by means of gutters and catchbasins or inlets rather than down through the pervious material of the intercepting drain. If the subdrain pipe is properly designed for size and stability, it may receive surface water from the inlets but consideration should be given to possible silting up due to a lack of self-cleaning velocity.

The above remarks regarding a sealed top to prevent silting apply to those conditions where surface water, from unsurfaced shoulders or other dirt areas, causes erosion and carries silt. On the higher type highways

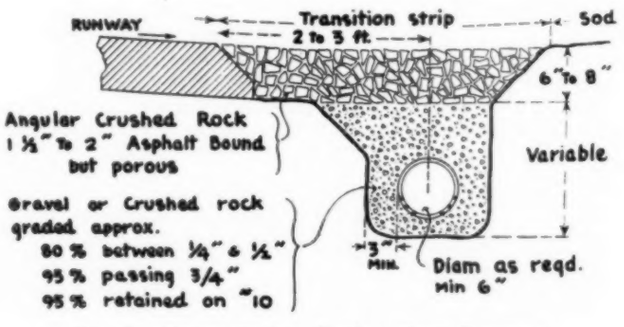


Fig. 4—Airport Surface Drains Along Runways.

where the shoulders are surfaced and other dirt areas are sodded or similarly treated, it is feasible to carry the pervious backfill up to the surface; thus making the drain act as a surface intercepting drain and eliminating the gutter, catchbasins, etc. It might be desirable in some cases to construct the surface of such drains in a similar manner to that suggested in Fig. 4.

Airport Surface Drains

The method of removing surface water on airports is necessarily different from methods used elsewhere. In storm sewer design, surface water is collected in and led to catchbasins or inlets by means of ditches or gutters which are not permissible on the flying area of an airport. Catchbasins have been used to some extent in surfaced areas but they are not very effective because of the difficulty of directing water over flat surfaces to a single point without unduly warping the surface.

The "surface intercepting drain" type, similar to that shown in Fig. 4, is the type most extensively used and the one which has proved the most effective. It intercepts uniformly distributed surface water either from the surfaced areas (runways, taxi-ways, aprons, etc.), or from sod areas. It may perform the dual function of collecting and removing surface water and ground water.

Some of the objections to the "surface intercepting drain" type which have been mentioned in the past are as follows:

1. Difficulty of keeping the porous backfill material level with the surface of the ground or preventing its displacement by wheels, tail skids and propellers.
2. Clogging of drains due to silting.
3. Weakening of the sidewalls of the trench due to erosion with consequent clogging of drains and caving in of sides of trench.

No doubt many of the drains, on which the above complaints were registered, were not constructed in accordance with the present-day recommendations shown in Fig. 4.

The transition strip serves two purposes:

1. It provides for the safe passage of planes across the runways in any direction. The ideal construction would provide a resiliency which is average between that of the sod and that of the runway surface.
2. It intercepts and collects surface water from the runway surface and from the sod area when such area slopes toward the runway. The use of crushed rock graded between the narrow limits of 1½ in. to 2 in. gives a maximum of large voids and when this material is premixed with just sufficient bituminous material to bind it together, it will become stable and provide free passage of water down to the drain pipe.

On newly constructed fields, where sod areas slope toward the surfaced areas (runways, etc.), some difficulty during the period of growing a sod may be encountered in preventing the silting up of the pervious transition strip. Various methods may be used but a quick growth of oats or other type of small grain together with some maintenance will usually give satisfactory results.

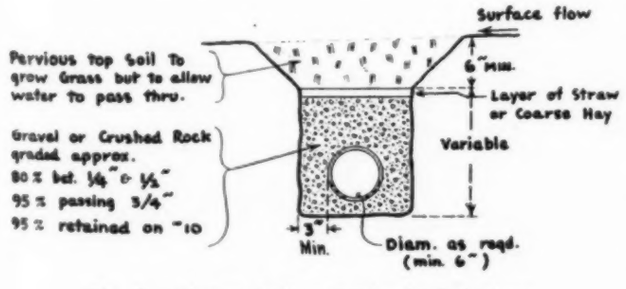
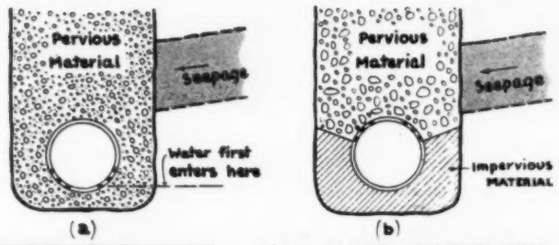

Surface flow
Pervious top soil to grow Grass but to allow water to pass thru.
6" Min.
Layer of Straw or Coarse Hay
Gravel or Crushed Rock graded approx.
80 % bet. ¼" & ½"
95 % passing 3/4"
95 % retained on #10
Variable
3" Min.
Diam. as reqd. (min. 6")

Fig. 5.—Airport Surface Drains in Sod Areas.



DOWN FOR USUAL CASE (To Prevent Silting)

UP for SOME CONDITIONS To eliminate loss of water before outlet is reached

Fig. 6.—Pipe Perforations—Up or Down?

The suggested pervious backfill under the transition strip is recommended for the same reasons as noted above for the highway intercepting drain.

When the drainage problem is only that of removing surface water, the drain pipe may be laid close to the surface providing the strength of the pipe is sufficient to withstand the transmitted surface load plus the weight of the fill material.

When the drainage problem involves that of removing ground water, the depth of the drain can be varied to suit the conditions. The removal of ground water may be necessary for the following reasons:

1. To lower the water table under the sod areas to promote a stable surface and yet provide sufficient capillary moisture to the grass root zone.
2. To prevent an unstable subgrade or frost heave under the runways by either lowering the water table or by intercepting sidehill seepage zones as shown for highway intercepting drains in Fig. 3.

The same care and investigation for the location and depth of airport drains is as necessary as in highway drainage.

Figure 5 shows a modification of the surface intercepting drain type to be used in the sod areas where it is advisable to intercept surface water at intervals to prevent or reduce surface erosion. These drains should be placed approximately perpendicular to the direction of the flow of surface water.

The pervious top soil is suggested instead of the crushed rock top (as shown in Fig. 4) to eliminate the unsightly appearance of crushed rock strips across the field and their resultant confustion to pilots.

Special care is needed in selecting the pervious top soil. It must allow the passage of surface water and yet be capable of growing grass. Such a soil has been very successful on Rentschler Field in East Hartford, Conn., which is a rather flat field having slopes not greater than 0.5 per cent. This scheme is not known to have been tried on airport surfaces having slopes of 1 and 2 per cent and on such slopes there might be a tendency for the surface water to pass over the trench.

A layer of straw or coarse hay between the top soil and the pervious backfill (gravel or rock) is very essential to prevent the filtering down of the fine material and eventually plugging the drain.

Infiltration Openings—Up or Down

Several types of drain pipe are now being manufactured having perforations in the walls of the pipe to provide for the entrance of water instead of allowing the water to enter at open joints. In most of such pipe the perforations are confined to from one-third to one-half of the pipe's periphery. The question is—shall the pipe be laid with the perforations up or down?

In Fig. 6 the two conditions are shown and it is recommended that the perforations should be down for the usual case. Water entering the pervious backfill material, either at the top or from the side, immediately drops to the bottom of the trench and enters the lower perforations when the water table is built up to that level. Therefore, with the perforations down, a lower water table is maintained in the trench or in the surrounding soil.

The most important reason for placing the perforations down is to prevent the entrance of solids (silt, sand and small particles of gravel). It is a well recognized fact that silting and plugging up is one of the principal causes for the failure of subdrains. As in sewers, once the solids have entered the pipe, velocity is the controlling factor in eliminating their deposit and the eventual plugging up of the drain.

Sewer designing engineers give serious consideration to this subject of self-cleaning velocities in the design of both sanitary and storm sewers.

The following table is taken from the 10th Edition of "Sewerage" by Folwell.

TABLE I.—MATERIALS MOVED BY WATER FLOWING AT DIFFERENT VELOCITIES. DuBAUT EXPERIMENTS.

Material	Bottom Velocity (Ft. per Sec.)	Mean Velocity (Ft. per Sec.)
Pottery clay	0.3	0.4
Sand, size of anise seed	0.4	0.5
Gravel, size of peas	0.6	0.8
Gravel, size of beans	1.2	1.6
Shingle, about 1" in diameter	2.5	3.3
Angular stones, about 1½" in diameter.	3.5	4.5

Knowing the required velocity to move the solids which may enter through perforations or open joints, the required depth of flow and discharge may be estimated for any size pipe and for any slope.

TABLE II.—DEPTH OF FLOW AND DISCHARGES REQUIRED TO MOVE VARIOUS SOLIDS IN 6-IN. DRAIN PIPE ON SLOPES OF 1.0 PER CENT, 0.5 PER CENT AND 0.1 PER CENT.
(n = .015 in Kutter's Formula)

Solids	Reqd. Vel. Ft./Sec.	Reqd. Depth of Flow (inches Reqd. Discharge [Gal./Min.]) to move solids	Slope 1.0%	Slope 0.5%	Slope 0.1%
Silt and Clay	0.3	Depth of flow	0.10"	0.22"	0.66"
		Discharge	0.65 gal.	1.09 gal.	2.48 gal.
Sand (approx. 30 mesh)	0.4	Depth of flow	0.16"	0.28"	1.06"
		Discharge	0.86 gal.	1.55 gal.	5.03 gal.
Gravel (¼ in.)	0.6	Depth of flow	0.32"	0.55"	1.95"
		Discharge	2.38 gal.	4.19 gal.	15.22 gal.
Gravel (⅜ in.)	1.2	Depth of flow	1.04"	1.64"	Not suf. when running full.
		Discharge	15.34 gal.	24.68 gal.	

The volume of ground water collected by the drain often varies between wet and dry seasons. During a long dry season there may be only a trickle flow or the pipe may be dry.

It must be remembered that the required velocities shown apply to loose material only. Where clay or sand has formed a compact deposit in the pipe, many times these velocities may be required to move it.

Because of the probable variation in volume of water a self-cleaning velocity cannot always be predicted. The safest procedure is to eliminate the entrance of solids by placing the perforations down.

Perforations should be placed up in those cases or in those portions of the line where there is danger of losing the water before the outlet is reached. Such loss of water might occur at only one spot in the entire line of pipe but this might defeat the purpose of the drain.

It has been mentioned that the drain pipe should be placed about 6 in. into the impervious zone, but this might result in puncturing a thin impervious zone and the loss of water into another pervious zone below. For this and other similar cases place the perforations up and also place an impervious material around the pipe so as to force the water into the pipe as shown in Fig. 6b. The pervious trench backfill (gravel or crushed rock) should then be a screened material of a minimum size which will not drop through the perforations.

In some cases a tight pipe (without perforations) would be advisable for certain portions of the line. An

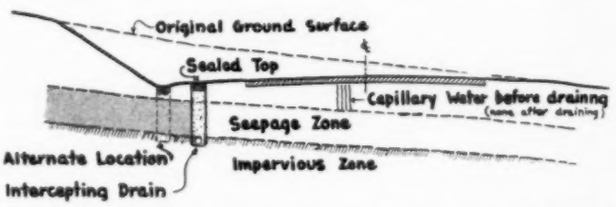


Fig. 7.—Intercepting Drain to Prevent Effective Capillary Rise from a Sidehill Seepage Zone. Case I: A Relatively Narrow Seepage Zone.

example of this is where a side drain is installed on the upper side of the road to intercept seepage and it is necessary to run across the road for an outlet. This outlet line should be of tight pipe to prevent loss of water in the filled shoulder. Or, if the tight pipe is not available on the job, use the perforated pipe with perforations up and with a covering of some sort over the perforations to prevent the dropping in of solids. Tar paper, straw or similar material can be used for the covering. The pervious trench backfill should be eliminated in the line below the point where seepage ceases to exist and by all means it should not be used in the filled shoulder. A bulkhead is often advisable at the end of the pervious backfill to prevent water following along the outside of the pipe.

Free outlets are very important. Failure of subdrains to properly function can often be attributed to a plugged up outlet.

It should be the duty and part of a maintenance man's jobs to see that all subdrain outlets are kept open. However, a better and surer procedure is to construct the outlets so that they cannot possibly become stopped.

Outlets frequently become completely covered over with earth washed down from filled slopes when the pipe line is ended at the toe of the slope. Outlet pipes projecting from filled slopes and suspended above the ground surface are an excellent type especially in northern states because of snow. It is much better to lay the last few feet of the outlet line on little or no slope than to obtain an obstructed outlet or one which will in all probability become obstructed.

Screens over the outlets are advisable to prevent small animals from entering and building nests.

Location and Depth of Highway Subdrains

We have been discussing proper construction to do a particular job, also certain precautions have been suggested to insure the proper functioning of the drain.

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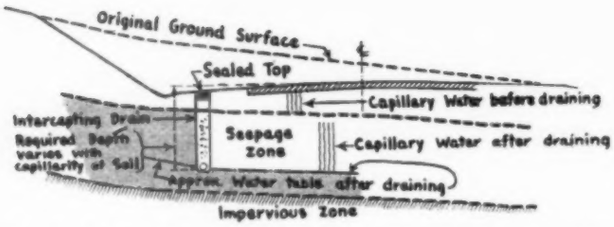

Fig. 8.—Intercepting Drain to Prevent Effective Capillary Rise from a Sidehill Seepage Zone. Case II: A Wide Seepage Zone.

The next important item is proper location and depth of drains and this discussion will be confined to typical highway problems.

The sidehill seepage condition is the one most commonly encountered. In Fig. 7, one of such conditions is shown where the top of the seepage zone is approximately from 2 to 4 ft. below the road surface and the bottom is approximately 7 ft. deep or less. In some cases the seepage zone has been found to be less than 6 in. thick, but usually it is found to be approximately 3 ft., or more thick. For this condition the damaging agent is capillary water which causes an unstable subgrade or frost heave. The solution here is to place an intercepting drain on the upper side of the road to completely shut off the free water before it enters the roadway area. The drain should be constructed as shown in and noted for Fig. 3.

On new construction the decision as to whether a drain is needed is necessarily based on the depth to the free water zone and the capillarity of the soil above that zone.

In Fig. 8, the conditions are similar to those in Fig. 7 except the seepage zone is thicker and the bottom is more than 7 ft. below the roadway surface. For such conditions where capillary water is the problem, the depth of the drain will be governed by the capillarity of the soil above the newly established water table. The pervious soil in the seepage zone should be checked but it will probably be a rather low capillary soil and a drain about 6 ft. deep will probably be effective.

Slides

Figure 9 shows a typical case of a slide on the fill side of the road caused by weight plus lubrication. The lubrication is water flowing laterally on top of a sloping impervious zone. The seepage water had always existed but when the fill was placed the balance between friction and weight was destroyed and the slide occurred. The solution is to intercept and remove all water above the impervious zone. The intercepting drain shown in Fig. 9 is located in the upper shoulder and for the conditions shown is probably the best and the point of minimum depth. But in some cases a shallower depth may be found on the slope above the road.

Figure 10 shows a typical slide above the road caused by lubrication plus lack of support. The tendency to slide on the lubricated plane (slip plane) always existed

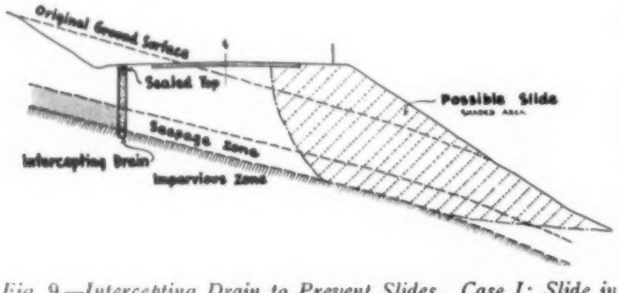

Fig. 9.—Intercepting Drain to Prevent Slides. Case I: Slide in Fill Section with Seepage Confined in a Sloping Zone.

but the support at the foot of the slope was sufficient to prevent the slide. When the excavation was made for the roadway, a sufficient amount of the support was removed to unbalance the conditions. The solution is to intercept and remove the water from the seepage zone at the most convenient place above the areas which show signs of movement.

Breakups Due to Longitudinal Seepage

Figure 11 shows a typical road breakup midway on the hill. Some of such breakups are due to transverse seepage or called "sidehill seepage" in Fig. 7, but many are due to so-called "longitudinal seepage." The breakup usually occurs at and below the point where the free water from the seepage zone contacts the subgrade. The free water sometimes bubbles up into the subgrade in the form of springs due to the head on the seepage zone. Very often those breakups occur at the intersection of the grade line and the original ground and many of these can be explained as follows: The seepage zone is very close to the original ground surface. During grading operations, rolling, etc., the free flow of water in the seepage zone is interfered with and the water is forced upward to the subgrade.

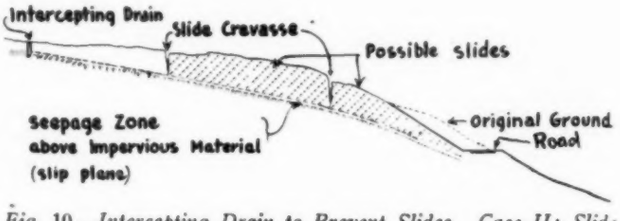

Fig. 10.—Intercepting Drain to Prevent Slides. Case II: Slide Above Road.

If investigations show the existence of a longitudinal seepage zone, an intercepting drain should be installed across the roadway some distance above the breakups. This lateral can be placed at right angles to the road or on a diagonal line, but in all such cases it should be open trench work even though necessary to cut a concrete slab. This is the only way to properly install an intercepting drain which will shut off all the water.

The suggestion has been made by some engineers, and in fact has been tried in one state, that a pipe be jacked or forced in behind a well point from the side of the road to tap the seepage zone. The object of this procedure is to save the cost of cutting and the cost of repairs of a cut in the roadway metal. This method cannot be consistently successful because the pipe merely taps the seepage zone and probably allows water to pass over and under.

The outlet line should also be of the intercepting drain type to insure against the possibility of a slightly diagonal flow. The direction of flow should be checked but it will usually be found to be from the deepest side of the cut.

Sometimes, in making excavations through hills longitudinal seepage zones are cut and water enters the roadway from both sides and from the subgrade. Intercepting drains on both sides are then needed and also possibly one or more laterals are needed as shown in Fig. 11.

Cut Slope Stabilization

Seepage zones exposed on the face of cut banks cause ragged looking slopes and very often result in mud and water, and sometimes ice, on the roadway. Figure 12 shows such a condition for a relatively low bank where

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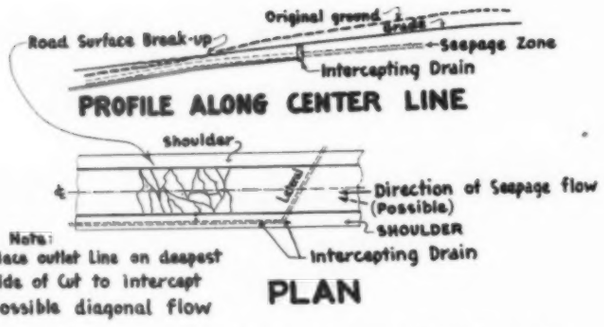

Fig. 11.—Intercepting Drain to Prevent Break-Ups from Longitudinal Seepage.

the bottom of the seepage zone is approximately not more than 6 ft. below the top of the bank.

Such conditions have been satisfactorily remedied by installing an intercepting drain on top of the bank which intercepts and collects the free water in the seepage zone. When the water is removed from the face of the bank, the soil becomes stable and the slope can be maintained as desired.

Figure 13 shows a relatively high bank with a seepage zone in the lower portion. The suggested treatment here is the same as for the conditions shown in Fig. 12, except that a shelf or terrace is recommended on the face of the bank just above the seepage zone. The shelf provides better working conditions and reduces the depth of the trench which must be excavated in reasonably stable soil.

The shelf also provides a suitable location for a surface water gutter to collect the rainfall on the upper portion of the slope and thus reduce surface erosion on the lower portion. In the opinion of many, terraced slopes on high banks improve their appearance and are much easier to maintain. The necessity for more grading and possible additional right-of-way are some of the objections to the terrace plan. However, a terraced bank with increased slopes might prove to be better than one long slope having the conventional pitch.

Level Water Table Conditions

As mentioned before in this paper, the level water table conditions are found in level country and especially in swampy sections. Also that the difficulty in draining such conditions is the usual lack of available outlets for drains of the required depth.

The acquiring of a stable subgrade by drainage for the level water table condition depends entirely upon the prevention of effective capillary rise to the subgrade zone. Therefore, the required depth of the drains depends upon the capillary property of the soils which should be determined before a decision on drainage is made.

Assuming that drainage is feasible, the locations for such drains are suggested in Fig. 14. Drains in both shoulder areas, shown in Fig. 14a and 14b, are preferable to the center drain in Fig. 14c. A better distribution of drainage is effected and the drains in that location may be very valuable in removing free water collected in a pervious base if same is used. The center drain is objected to by some engineers because it is placed under the pavement and is inaccessible in case of trouble. However, with properly constructed drains this objection is believed to be of minor importance. When drainage is installed after pavement construction, a drain on each side is generally cheaper than a drain in the center plus the cost of cutting the pavement and of making repairs. In Fig. 14b is shown an alternate location in the area between the toe of slope and the ditch. Because of less excavation and less backfill, this drain will be cheaper

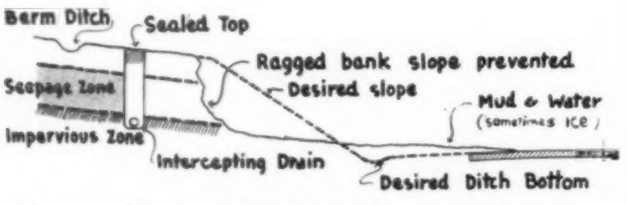

Fig. 12.—Cut Slope Stabilization with Intercepting Drains. Case I: Low Banks.

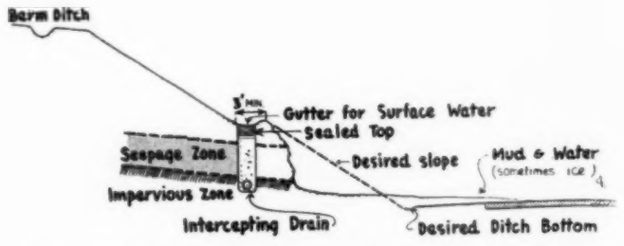

Fig. 13.—Cut Slope Stabilization with Intercepting Drains. Case II: High Bank with Seepage in Lower Portion.

but will not be as effective as a drain in the shoulder close to the pavement.

When drainage to prevent effective capillary rise is not feasible, other methods to establish a stable subgrade must be used. The choice then lies between raising the grade with pervious materials or excavating and replacing with pervious materials. In either case, drains are recommended in locations where water may be collected in such pervious bases.

Free water may collect in the pervious base under several different conditions. The water table may actually rise into the pervious base during an exceptional wet season. Or it may be high enough to supply capillary water in considerable quantities to the pervious base.

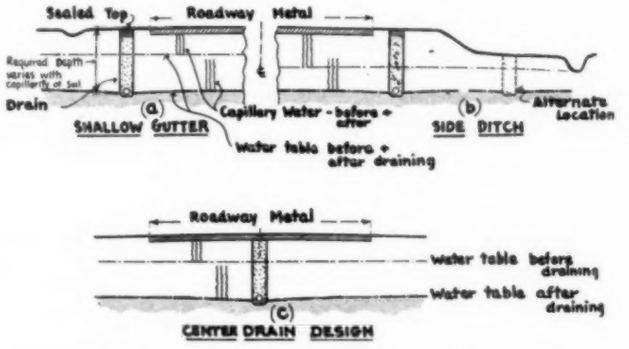

Fig. 14.—Level Water Table Condition. Deep Drains to Prevent Effective Capillary Rise (When Outlets Are Available).

If and when the frost zone reaches the bottom of the pervious base, ice layers will be formed. When these ice layers melt they turn into free water which should have an outlet to prevent a mushy and unstable sub-base. To remove such free water, drains as shown in Fig. 15 are recommended.

In Fig. 15a and 15c it is assumed that outlets are available for very shallow drains only and therefore no attempt is made to lower the normal water table. The location in 15a is preferable because the free water will drain toward the shoulder over a naturally crowned subgrade. In Fig. 15c the subgrade must be sloped toward

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Later, efficient helical cut gears replaced the old-fashioned spur gears.

To these two important features were supplemented spline shafts, square lever shafts, synchro-power clutches and many other important advantages, all of which, when combined, result in a quiet, economical and smooth running excavator that lowers operating costs and increases production on any construction or material handling job requiring shovels, draglines or cranes. ● ● ●

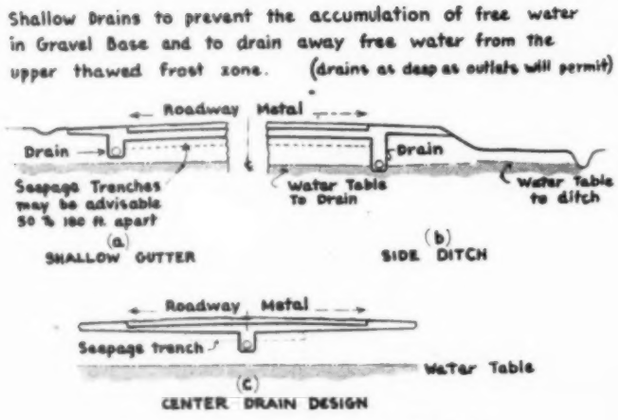

Fig. 15.—Level Water Table Condition.

the center drain and this is objected to by many engineers because water is invited or forced to go to the center of the road.

For the side ditch conditions (Fig. 15b) a somewhat deeper drain is shown because a deeper outlet is available. Where possible the deeper drain is advisable to insure against a higher water table and an increased amount of capillary water to the pervious base. Water tables are sometimes raised because of standing water in poorly maintained ditches.

Transverse seepage trenches, as noted in Fig. 15, are sometimes advisable to assist in moving the water collected in the pervious base to the drains.

Summary

When subdrainage is needed there is no real substitute and the best that can be obtained is the least that should be considered.

The cost of good drainage for the infrequent wet spots is only incidental to the cost of the road per mile.

The location and depth of drains should not be guessed at but they should be installed to fit the actual conditions.

Because the continued functioning of drains is so important every precaution should be taken in their construction to obtain the maximum of efficiency and the longest life possible.

Most free ground water conditions encountered in highway construction and maintenance are of the side hill seepage class and therefore the intercepting drain type is the one most frequently needed. Because adequate outlets are generally available, nearly all of these conditions can be satisfactorily drained.

Acknowledgment—The foregoing is a paper presented at the recent Convention of the American Road Builders' Association.

▼

Highways in China

Approximately 60,000 motor vehicles (about 75 per cent of which are of American manufacture) were in operation in China including Manchuria and Hong Kong on January 1, 1937, on a total of about 60,000 miles of highways. During the past year, the closing of gaps in main arterial routes and the opening of the latter to traffic have been significant developments in the betterment of transportation facilities and the unification of the country. Furthermore, the unification, standardization and improvements in maintenance of highways and motor transport mark important developments. It is now possible to motor from Nanking, the nation's capital, 200 miles from the mouth of the Yangtsze River, to Yunnanfu in Southwest China, a distance of 2,000 miles within 8 days' time. It is also practical now to motor from Shanghai to Chengtu, the capital of Szechwan, and within the next year a highway will have been constructed from there westward to the borders of Thibet. Toward the end of 1936 a commission of technical engineers of the Bureau of Roads completed a 6,000 mile inspection tour in motor cars covering 9 provinces. Bus lines are operating regularly throughout this region.

In Manchuria by the end of 1936, there was completed the first 3 years' program of new highways aggregating 9,000 km. and 18 large bridges. In addition to these a network of strategic roads was hastily built in unpacified areas by forced rural labor. New bus services were established to operate over these highways under the direction of the General Directorate of Railways.

▼

Road Construction Through Thermal Areas

In a paper on soil stabilization on the highways of Yellowstone Park, presented at the 1937 Highway Conference of the University of Colorado, C. P. Capes, Highway Engineer, U. S. Bureau of Public Roads, gave the following information on the construction of highways in the thermal areas of the park:

"Construction through the various thermal areas in the park involves about the same problems as encountered in other drainage situations and are corrected substantially as for other poor subgrade conditions in the park. These steam vents and geysers, however, are constantly changing in volume and location, and one which has been apparently adequately drained and put under control this season may develop increased pressure or volume during the winter and next spring we find our work, so to speak, "blowed up." On the other hand, the vent which has been corrected may close up and dry up of its own volition by clogging in some subterranean passage and may erupt in some entirely different spot a few feet, a few hundred feet, or a half-mile away.

"Although we have some very poor clays to deal with in these thermal areas, their immediate vicinity consists principally of siliceous material formed and deposited through the ages by the geysers. This geyserite is a good roadbed foundation materal, and certain deposits which resemble disintegrated granite in composition and can be excavated with a power shovel, are advantageously used for admixture with the clays and, also, as selected material courses or fills over other less suitable materials.

"Where these hot spots, or springs, must be crossed with the highway, an endeavor is made to raise the grade 4 to 6 ft. above the vent. A porous tile several times larger than is apparently needed to carry the normal flow is installed and covered with large rock to allow free ventilation. The interstices of the coarse rock are gradually closed by using coarse gravel and sand filler and then about a 2-in. mat of premixed bituminous material is spread and compacted over the whole installation. This is to prevent the steam and moisture from rising up into the subgrade of the road."

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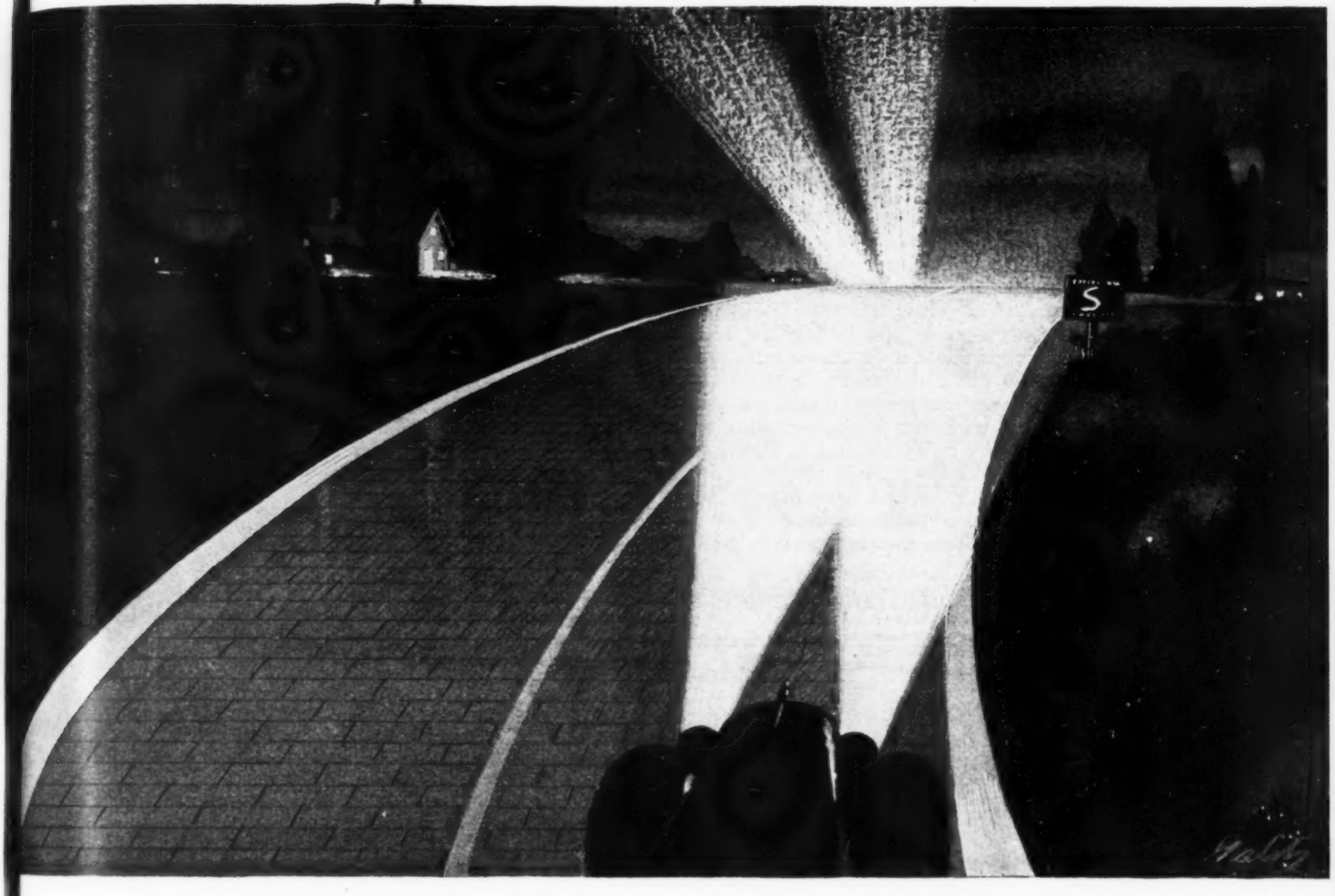

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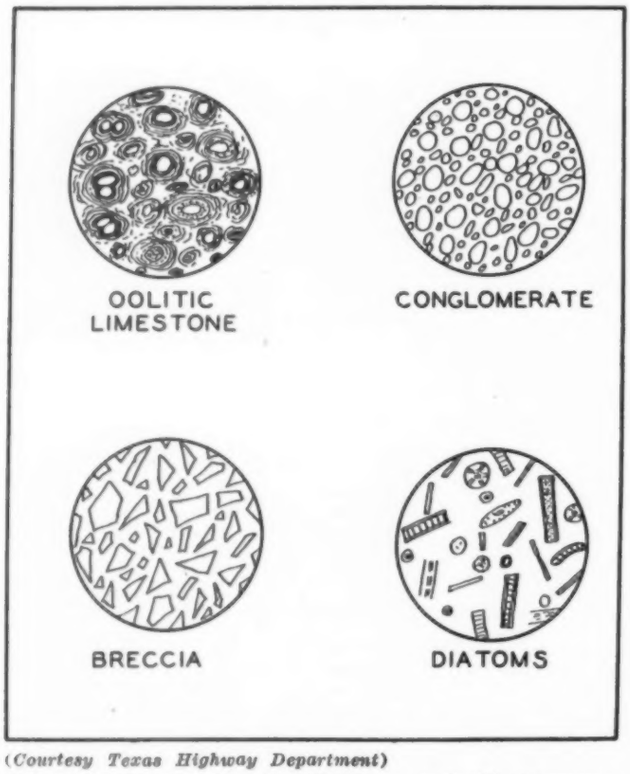
THE SAFE PAVEMENT FOR MOTORIZED TRAFFIC

A GLOSSARY OF GEOLOGICAL TERMS FOR THE HIGHWAY ENGINEER (REVISED)

By D. G. RUNNER
Assistant Materials Engineer, U. S. Bureau of Public Roads

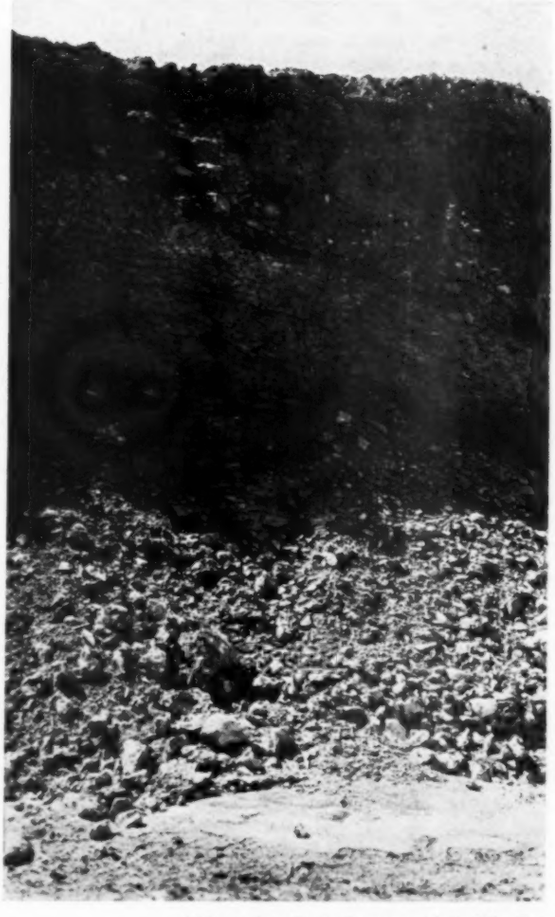
THERE are now available several glossaries of terms suitable for use in highway engineering. One of such glossaries may be found in the 1936 Powers Roads and Street Catalog and Data Book. Another such list of highway terms has been provided by The Asphalt Institute in their Manual Number 2, entitled "Asphalt Road Construction." These glossaries are chiefly applicable to the definition and explanation of terms dealing with road construction in its various fields. It was thought that a list of explanatory terms and definitions relating more to the geologic phase of materials as applied to road building would be of interest to the highway engineer. Accordingly the following definitions and terms are presented with this thought in mind. This glossary was originally published in the March, 1936, issue of ROADS AND STREETS. Since that time a sufficient number of new definitions have been added to warrant publishing this revised edition.* The numbers in parentheses after the terms refer to the source of the reference, or to literature where discussion of the subject matter may be found.

*The writer, in coauthorship with Victor J. (Vic) Brown, Publishing Director of Roads and Streets, is preparing a comprehensive glossary of technical and geological terms for the highway engineer, contractor and student.



(*Courtesy Texas Highway Department*)

Fig. 1—Sketch Showing the Structure of Oolitic Limestone, Conglomerate, Breccia, and Diatoms which Form "Diatomaceous Earth"



(*Photo by U. S. Bureau of Public Roads*)

Fig. 2—A Deposit of "Hard" Caliche, Texas

—A—

Aa—A Hawaiian word for rough, scoriaceous lava.

Accessory Minerals (Rock)—In rocks are original constituents of the rock, found only in small, often only in microscopic quantity. (5)

Acidic—A term applied to rocks in which silicic acid (silica) or quartz predominates. (5)

Adobe—An impure calcareous clay, widely used in western United States for making semi-dried bricks. (1)

Aggregate—The inert material, such as sand, gravel, shell, slag or broken stone or combinations thereof, with which the cementing material is mixed to form a mortar or concrete. (2)

Albertite—A black bitumen with a brilliant luster on broken surfaces, a hardness between 1 and 2, and a specific gravity a shade over 1. (1)

Alluvium—Deposits of mud and silt commonly found on the flat lands along the lower courses of streams.

Amorphous (Rock)—Without crystalline structure, such as volcanic glass.

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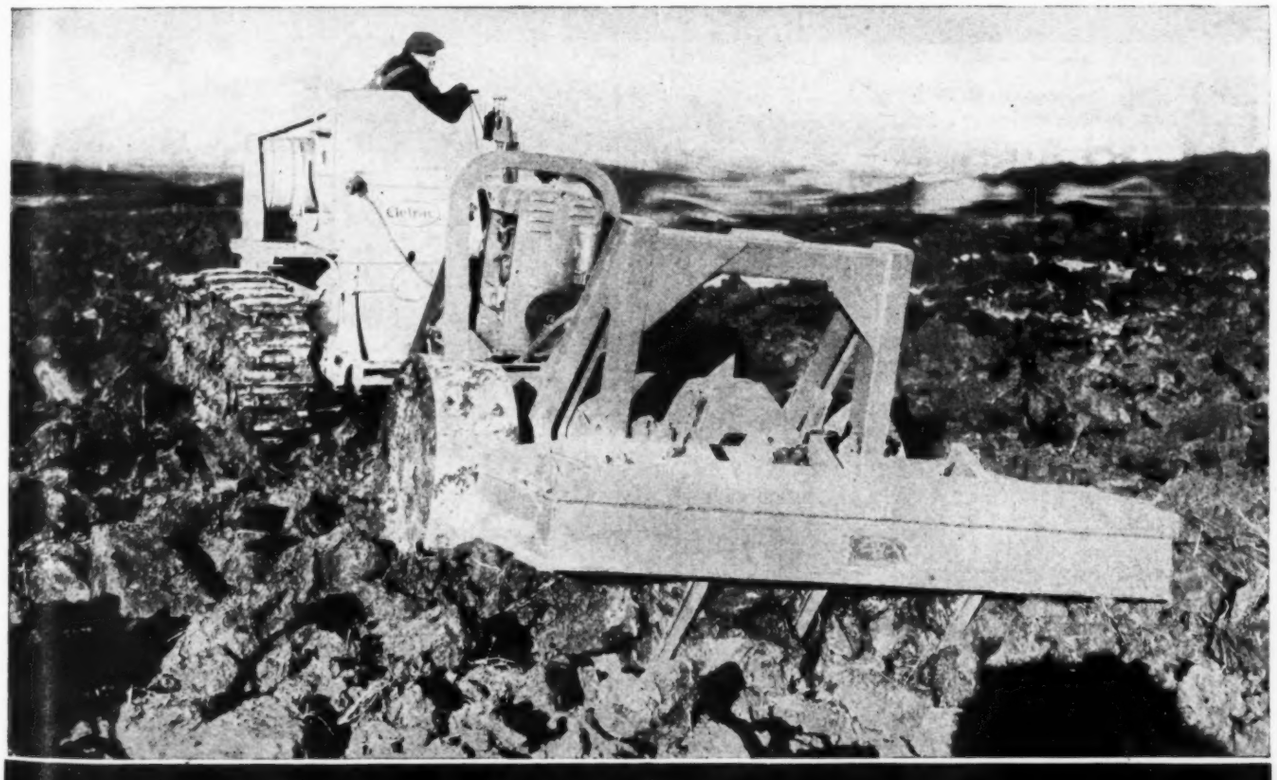

CLETRAC CRAWLER TRACTORS

Fig. 3—Coquina Limestone

Anticline—A term applied to granite sheets or sedimentary beds that form an arch. (5)

Aphanitic (Rock)—Refers to rocks that are so fine grained that the individual minerals cannot be distinguished by the naked eye.

Aplite (Rock)—A fine-grained granite, generally occurring in dikes and containing little mica and a high percentage of silica. (5)

Aqueo-Igneous—Commonly applied to rocks and minerals which have been produced by the combined action of water and heat.

Arenaceous—From the Latin word "arena" meaning sand. Like or pertaining to sand. An example is arenaceous limestone, or a sandy limestone. (3)

Argillaceous—Containing or consisting of clay. An example is argillaceous limestone, meaning one containing a high percentage of clay. (3)

Arkose—Is a sandstone composed of quartz and feldspar grains, usually derived from the disintegration of granite and not transported far. (1)

Ashes (Volcanic)—Fragments of lava and pieces of rock driven upwards by violent expansion and expulsion from active volcanoes.

—B—

Bank Gravel—Gravel found in natural deposits, usually more or less intermixed with fine material, such as sand or clay, or combinations thereof; gravelly clay, gravelly sand, clayey gravel and sandy gravel, indicate the varying proportions of the materials in the mixture. (2)

Banded (Rock)—Is a term applied to rocks having thin and nearly parallel bands of varying colors, minerals or textures. (3)

Basalt—Any volcanic rock of micro-crystalline or amorphous texture, dark color and high true specific gravity, indicating porous or volcanic basalt which by reason of its structure has a low apparent specific gravity. (2)

Basic—A term applied to rocks in which the iron-magnesia minerals and feldspars with lime and soda predominate, such as diabase or basalts. (5)

Bed (of Rock)—A single layer or stratum of rock, which may be either an inch or a hundred feet or more in thickness.

Bedding Plane (Of Rock)—Refers to the plane of junction between different beds or layers of rock. (6)

Bentonite—The plastic residue from the weathering of ash (volcanic); it swells enormously in water and forms a milky suspension. (7)

Black Horse—Term used by quarrymen to denote a dark biotite gneiss in contact with the granite. (5)

Blind Seams—Quarrymen's term for incipient joints. (5)

Boulders—Are detrital material greater than 200 mm. or about 8 inches in diameter. (6)

Boulder Quarry—One in which the joints are either so close or so irregular that no very large blocks of stone can be quarried. (5)

Breccia—Is a deposit containing a large proportion of coarse, angular rock fragments. See Fig. 1.

Buhrstone (Rock)—Is a term given to a variety of quartzite which is full of long drawn out holes. Sometimes used as millstones.

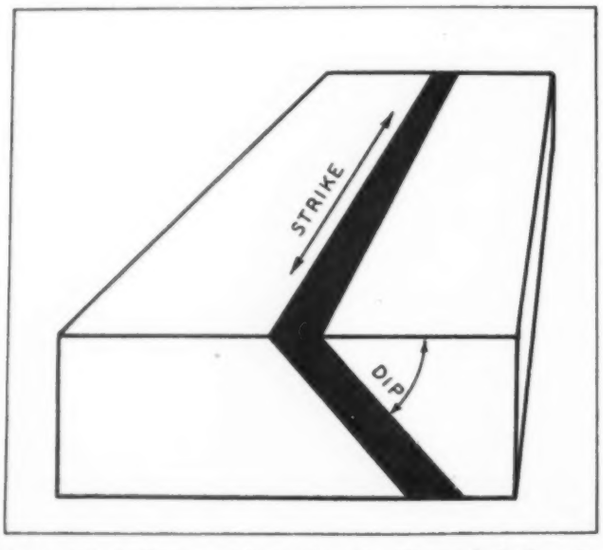

Fig. 4—Block Diagram Illustrating the Dip and Strike of a Stratum

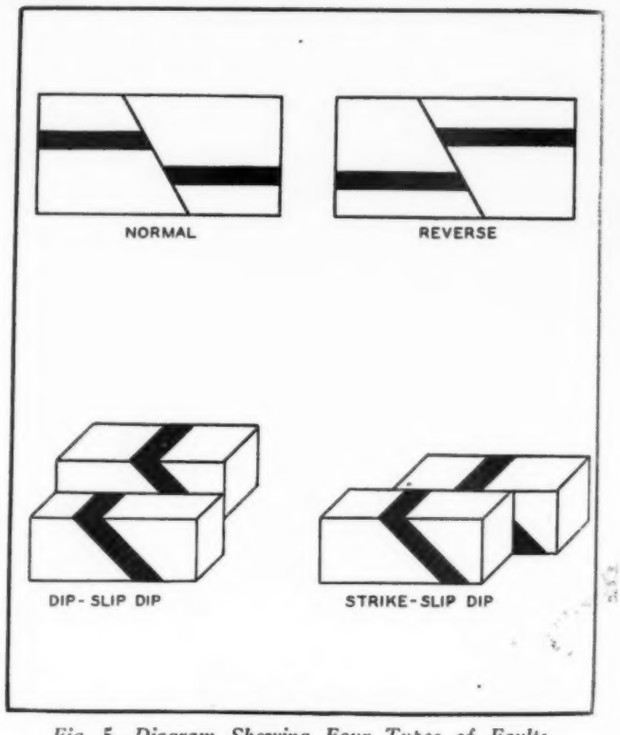

Fig. 5—Diagram Showing Four Types of Faults (After Lahee)

—C—

Caliche—A material found chiefly in the southwestern part of the United States. It is composed essentially of soft limestone with varying percentages of clay. Fig. 2 shows an outcrop of caliche in Texas. (8)

Cellular (Rock)—Refers to the porous texture, and fairly large cavities of certain volcanic rock.

Channel—A narrow artificial incision across a mass of rock, which, in a granite sheet, is made either by a series of contiguous drill holes or by blasting a series of holes arranged in zigzag order. (5)

Chalcedony (Rock)—Is a waxy form of silica, having the density and hardness of quartz but a minute fibrous structure.

Chats—The gangue material which is found intimately mixed with the lead-zinc ores of Missouri and Oklahoma. It is closely akin to chert and is the by-product of metal mining.

Chert—A very fine-grained dense rock consisting of opal or chalcedony, often with some quartz, and sometimes with accessory calcite, iron oxide, organic matter, sponge spicules, or

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HIGH COMPRESSION ADDS MORE POWER

other impurities. It is usually associated with limestones, either as entire beds or as isolated included masses. It has a homogeneous texture, and a white, gray, or black color. (9)

Clay—A fine argillaceous material which is more or less plastic when wet. The most important constituent of clay is hydrous-alumina-silicate gel, a colloidal material, which remains suspended indefinitely in water, but may be thrown down as coagulated matter by salt solutions. When dry, clay is a fine, earthy material having a characteristic odor when moistened by the breath. It clings to the tongue, and makes a smooth paste when rubbed to an incoherent mass between the fingers. When pure, clay is white, but it is commonly colored yellow, brown, or red by iron oxides, or gray, blue, or black by organic matter. The grain size of clay is commonly considered as minus 0.005 mm. (10)

Clay-Gravel—Gravel which, in addition to the smaller-sized particles of silica, contains a percentage of clay so that under the puddling action of the drag, a certain cementitiousness is developed which produces a dense, firm surface. (22)

Cleavage—Is that capacity of certain rocks to part along parallel planes. It may be original in beds or secondary in metamorphic rocks. (7)

Close-Jointed (Rock)—A term applied to rock containing joints that are very near together. (5)

Coarse-Grained (Rock)—Refers to the texture of rock in which the individual minerals are large enough to see with the naked eye. Some authorities consider coarse-grained minerals to be larger than 5 mm.

Conglomerates—Consist of pebbles of various sizes, intermixed with a finer material which acts as a cement. The pebbles may vary in size from a small pea to large boulders, and all are well rounded by water action. See Fig. 1.

(Courtesy Consolidated Feldspar Corporation)

Fig. 6—A Feldspare Mine Located at Keystone, S. Dak.

Coquina—Consists essentially of marine shells which are held together by a little calcium carbonate cement so as to form a fairly firm rock. It is full of cavities but is strong enough for use in building operations. The classic example is the "coquina" of the east coast of Florida. See Fig. 3.

Crocus—A term used in some quarries to denote gneiss or any other rock in contact with granite. (5)

Crush-Border—A microscopic granular structure sometimes characterizing adjacent feldspar particles in granite in consequence of their having been crushed together during or subsequent to their crystallization. (5)

Crusher-Run—Refers to the product of the crushing plant without being rescreened or separated into various sizes.

Crystalline (Rock)—Is commonly applied to those rocks consisting of crystallized minerals and no glass.

Cut-Off—Quarrymen's term for the direction along which the granite must be channeled, because it will not split. Same as "hard-way." (5)

—D—

Dendrites—Plantlike crystallization of iron or manganese oxides on the surfaces of fissures in any rock or mineral. (5)

Diatomaceous Earth—Is composed essentially of the siliceous skeletons of diatoms, extremely minute uni-celled organisms. It is composed mainly of silica, white or light gray in color, and is extremely porous. See Fig. 1.

Dike—A mass of granite, diabase, basalt, or other rock which has been erupted through a narrow fissure. (5)

Dimension Stone—A term applied to stones that are quarried of required dimensions.

Dip (Of Rock)—Is the angle of inclination of the plane of stratification with the horizontal plane. See Fig. 4.

Dolomite—A magnesian limestone, composed essentially of the mineral dolomite, a double carbonate of calcium and magnesium. It is theoretically composed of 54 per cent calcium and 46 per cent magnesium carbonate. (2)

Fig. 7—A Deposit of Field Stone, West Virginia

Drift—Sand and boulders deposited by glaciers. (11)

Drumlin—Is a term applied to rounded oval hills of clay and boulders formed by action of glaciers. (11)

—E—

Erosion—The wearing away of portions of a rock by such natural agencies as stream or ice action. (5)

Essential Minerals—The essential constituents of a rock are those minerals whose presence are necessary in it by definition.

Exfoliation (Rock)—The peeling of a rock surface in sheets owing to changes of temperature or to other causes. (5)

—F—

Faults—May be considered as an abrupt break in the continuity of the beds or strata with the elevation or depression of beds on one side of the plane of the fault. See Fig. 5. (12)

Felsitic (Rock)—Is an adjective applied to textures that are too fine to be determined with the naked eye.

Feldspar—Constitutes one of the most important group of rock-forming minerals. It is estimated that about 60 per cent of the earth's crust is composed of this mineral group. See Fig. 6.

Field Stone—Loose rock usually of assorted sizes and character found upon the surface of the ground. Such material is usually associated with nearby occurring outcrops of rock. See Fig. 7.

Fine-Grained (Rock)—Refers to those rocks in which the minerals are about 1 mm. or less in diameter.

Flagstone—Is a thin bedded sandstone, often with mica, which splits easily and uniformly along the bedding place; so that it can be quarried in large slans. (1)

Flint—A sedimentary rock, dark gray to black in color, hard, dense, and composed essentially of minutely-crystalline silica

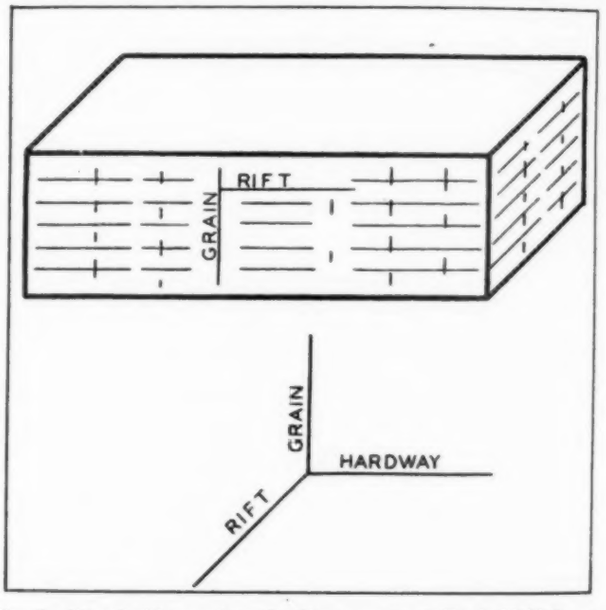

Fig. 8—Sketch Illustrating the Structures of Rock Which are Closely Associated with Jointing. The "Rift" Is the Easiest Way of Splitting, and the "Grain" Is Usually at Right Angles to the Rift. The "Hardway," or Head Grain, is the Direction at Right Angles to Both the Rift and Grain

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Fig. 9—An Outcrop of Rock Showing Vertical and Horizontal Jointing

with little chemically combined water. Flint is commonly found in chalk beds.

Flow Structure (Rock)—The parallel arrangement of the minerals in granite or other igneous rock in the direction of its flowage during its intrusion. (5)

Flour—Finely ground rocks or minerals pulverized to an impalpable product. (22)

Foliated (Rock)—Refers to the texture of schists in which certain minerals, such as mica, are undulating and wavy in arrangement in the rock.

—G—

Gangue—The non-metallic minerals found with ores.

Geode—A rock cavity lined with crystals. Geodes in granite are attributed to steam or gas bubbles. (5)

Gilsonite—A hard, brittle, native asphalt occurring in various localities in rock crevices or veins from which it is mined like coal. (13)

Glassy (Rock)—Lavas which have cooled so quickly that they are without distinct crystallization. (1)

Granite—A crystalline, even-grained rock consisting essentially of feldspar and quartz with smaller amounts of mica and other ferro magnesian minerals. (15)

Gneiss—A medium of coarse-grained crystalline rocks possessing some form of parallel structure due either to the uniform orientation of certain tabular or prismatic minerals, or to the presence of wavy discontinuous surfaces indicating a lenticular structure or of bands of varying mineralogical composition which retain their continuity and parallelism throughout a considerable mass of rock. Some examples are, banded gneiss, granite gneiss, etc. (14)

Grain (Of Rock)—Refers to the direction of splitting at right angles to the "rift." See Fig. 8.

Gravel—The granular, pebbly material (usually coarser than ¼ inch in diameter) resulting from the natural disintegration of rock. The rounded character of some gravel particles has been imparted by stream action.

Graywacke (Rock)—Is a sandstone composed of quartz, feldspar, and some other mineral, like hornblende, augite, etc., also derived from the disintegration of granites and not transported far. (1)

Grit—A coarse sand formed mostly of angular quartz grains. (16)

Grout—A term applied to the waste material of all sizes obtained in quarrying stone. (5)

Grow-On—Quarrymen's term to designate the place where the sheet structure dies out, or the place where two sheets appear to grow onto one another. (5)

Gumbo—The natural soil found in certain parts of the middle west, notably Minnesota, the Dakotas, Missouri, and Iowa, which is finely divided clay of varying capillarity. (17)

—H—

Hardpan—A soil which may be either (a) a very dense subsoil, such as tough clay, (b) a cemented layer in the soil where ground waters have precipitated a local binder of silica carbonates, iron oxides, etc., or (c) dense clayey glacial drift. (18)

Hardway (Rock)—The direction at right angles to both rift and grain in which granite does not split readily. See Fig. 8. (5)

Heading (Rock)—A collection of joints. (5)

—I—

Igneous Rocks—Are those which have been formed or crystallized from molten magmas, the source of which has been the earth's interior. Examples of this type are the granites, syenites, gabbros, etc. (15)

Indurated—Refers to rocks that have been hardened by heat. Occasionally the term is applied also to sediments hardened by impregnating solutions. (3)

Intermediate Rocks—Applies to rocks intermediate in silica content between the *basic* and the *acidic* groups.

Intrusive Rocks—A term applied to those rocks which have been injected into other rocks.

—J—

Jasper (Rock)—Is an impure form of silica which owes its bright colors to the presence of iron oxides.

Jasplite (Rock)—Is the term given to banded rocks consisting of alternating layers of hematite and red chert.

Joints (Rock)—Traverse the rocks in different directions and at various angles, and in most areas there are at least two systems. The spacing of joints may vary greatly, sometimes being measured in inches, at other times in yards. Joints are a matter of practical importance as the system and extent of this feature governs the size of the stone that can be removed from the quarry. See Fig. 9. (4)

—K—

Kaolin—A white non-plastic material, consisting in the raw state, of the mineral kaolinite (pure hydrated silicate of alumina) mingled with fragments of quartz, feldspar, mica, the residual minerals of granite. (6)

Kaolinization—The process by which a feldspar passes into kaolin. (5)

Knots—A term applied by quarrymen to dark-gray or black objects, more or less oval or circular in cross-section, which are segregations of black mica or hornblende formed in the granite while in a molten state. (5)

—L—

Lamella—A thin scale, or plate.

Lamina—A thin sheet.

Laminations—Refer to the banding in rocks caused by variations in color of different minerals. Quite often these laminations result in the rock breaking easily along the laminated portion. This feature is exemplified in the gneisses.

Lava—Is a term applied to both the hot liquid magma and to the cold solid rocks which are formed when the magma "freezes."

Lapilli—The smaller fragments of lava ejected from volcanoes.

Lenticular—Lens-shaped. (3)

Lime Rock—A natural material found chiefly in Florida and Georgia. It is composed essentially of calcium carbonates with varying percentages of silica. Lime rock hardens upon exposure to the elements and some varieties provide excellent road metal. See Fig. 10. (19)

Limestone—Any natural rock of sedimentary origin composed essentially of calcium carbonate or of calcium and magnesium carbonates in either its original chemical or fragmental, recrystallized form. (2)

Limonite—A hydrous oxide of iron; a hydrated hematite, which when scratched or powdered, gives a brownish rust color. (5)

Loam—Finely divided earthy material containing a considerable proportion of organic matter. (22)

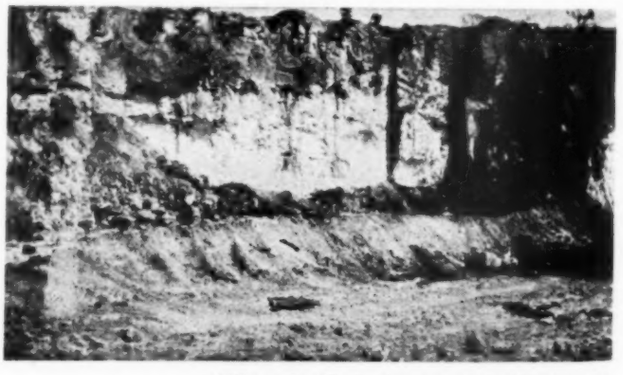
Loess—Is wind blown silt or silty clay having little or no stratification. Some of its peculiarities are the light color, fine state of subdivision, the sharpness and angularity of its particles, its porosity and coherence. See Fig. 11.

Lutaceous—A term relating to rock flour and other materials of clay size.

—M—

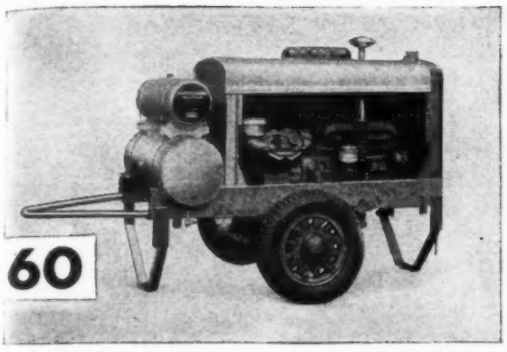
Magma—Is the natural fluid in the earth, usually hot and made up of silicate solutions together with oxides, etc. It also contains water and other gases held in solution.

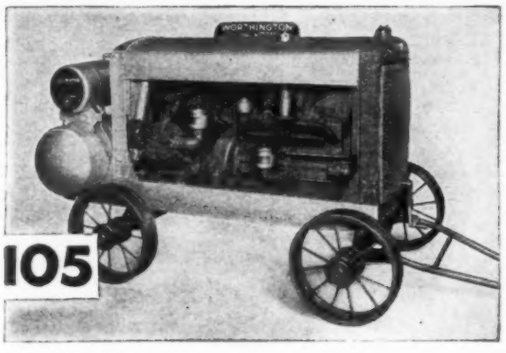
Marl—An earthy mixture of minerals consisting of quartz, clay, calcite, and sometimes glauconitic sands. It is quite often found in swamps and in lakes.

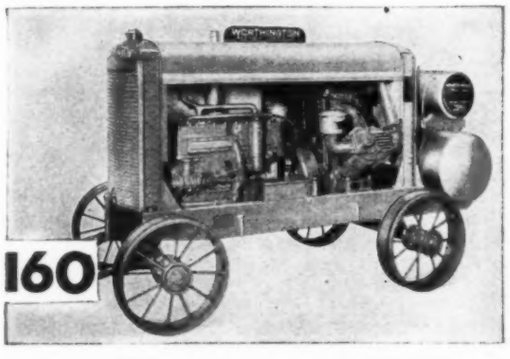


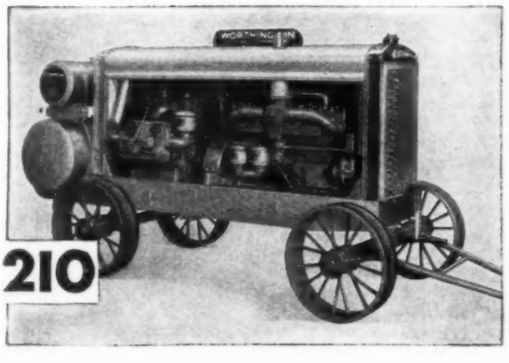
(Photo by U. S. Bureau of Public Roads)

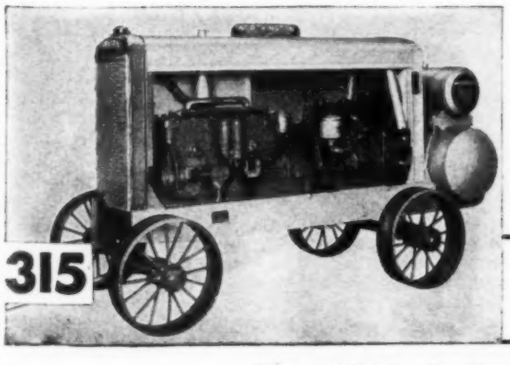
Fig. 10—An Outcrop of Ocala Lime Rock in Florida











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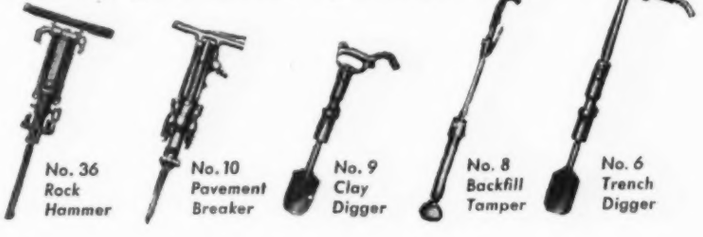
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Marble—Any crystalline or micro-crystalline natural rock deposit of sedimentary origin composed principally of calcium carbonate or calcium and magnesium carbonates. This classification includes also those serpentines that are of igneous origin as well as those of sedimentary origin. (2)

Matrix (Rock)—The general mass of a rock which has isolated crystals; sometimes called groundmass. (5)

Medium-grained (Rock)—Refers to rocks whose crystals have an average diameter of between 1 and 5 mm.

Megascopic—A term applied to observations with the unaided eye, as opposed to microscopic, made with the aid of the microscope. (3)

Metamorphic Rocks—Are those rocks which have been changed by temperature, pressure, and chemical fluids into new forms being more stable under the new condition. Some examples are: gneisses, schists, marbles, etc. (14)

Microcrystalline (Rock)—Refers to granular rocks in which the various constituents can be determined only with the microscope.

Mineral—A natural inorganic substance of definite chemical composition. (1)

Motion—A term used in granite regions to designate small paving-block quarries. (5)

—N—

Natural Bed (Rock)—The surface of a stone parallel to its stratification. (18)

—O—

Oolitic Limestone—Those limestones consisting largely of minute spherical or ellipsoidal grains of calcium carbonate which resemble fish roe. See Fig. 1. (6)

Ophicalcite (Rock)—Is the name given to rocks consisting of a mixture of white calcite and green serpentine.

Ophitic—A term applied to microscopic rock texture to designate a mass of longish interlacing crystals, the spaces between which have been filled with minerals of later crystallization. (5)

Organic—The product of animal or vegetable life. (18)

Orogenic—A term relating to the formation of mountains.

Outcrop (of Rock)—Those places where the underlying bedrock comes to the surface of the ground and is exposed to view. See Fig. 12.

Overburden—Refers to the soil mantle, waste material, or other similar matter found directly above the deposit of rock or sand-gravel. The amount of this overburden has a direct economic effect upon the amount of material capable of being produced.

Fig. 11—Loess Soil, Passing No. 20 Sieve, Retained on No. 40 Sieve. X20

(Courtesy Ward's Natural Science Establishment)

Fig. 12—An Outcropping of Limestone, Showing a Sharp Angle of Dip, and Extreme Degree of Stratification, West Virginia

—P—

Pahoehoe—A term for lava which has a ropy smooth surface.

Pebbles—Rock fragments of small or moderate size which have been more or less rounded by erosional processes. (20)

Pegmatite—A very coarse granite occurring in irregular dikes or lenses in granites and some other rocks. See Fig. 13. (5)

Phenocryst—A term applied to isolated crystals visible to the unaided eye and lying in the mass of a rock of igneous origin. (5)

Phosphate Rock—Is one composed chiefly of calcium phosphate along with various impurities, such as clay and lime. It occurs in beds, irregular masses, or as concretionary nodules in limestone or sand. (1)

Phyllite (Rock)—Is applied to a group of rocks associated with slate. The name means "leaf stone," because of the well defined cleavage. Phyllite usually contains larger amounts of mica than the normal slates.

Plagioclase—A term applied to all those feldspars that are not potash feldspars. (5)

Platy Structure (of Rock)—Refers to the structure developed in certain igneous rocks so that it breaks into plates parallel to the cooling surface.

Porphyritic (Rock)—A term applied to rock texture to designate the presence of isolated crystals in a general mass (matrix or groundmass) or finer material. (5)

Pseudomorph—Signifies false form and designates a crystal in which, owing to various chemical changes, the original mineral has been more or less replaced by others. The form of the crystal no longer corresponds to the mineral. (5)

Pumice, Pumice Stone, Pumicite—Those rocks are composed of highly vesicular volcanic glass, resulting from the hardening of the glass froth occurring around the vent of an active volcano. The color is white, gray, yellowish or brown and sometimes red. On examination with a lens, the material is seen to be composed of a mass of silky glass fibers of a cottony appearance, extremely porous like a sponge. See Fig. 14. (21)

—Q—

Quartzite—A dense sandstone rock which has been thoroughly cemented by silica or which has been indurated or hardened by a recrystallization process.

Quartz—Is composed essentially of silica (Sio_2), is colorless when pure, but often tinted yellow, red, blue, violet. It has a specific gravity of 2.65, and is the most common mineral in sand.

—R—

Random Stone—A term applied by quarrymen to quarried blocks of any dimension. (5)

Red-Dog—Is the residue from burned coal dumps. The dumps are composed of waste products incidental to coal mining, which are not true coal but contain a certain percentage of carbon. Under pressure in the waste dumps, they frequently ignite from spontaneous combustion and the residue is a red-colored ash containing a high percentage of silica with certain salts distributed throughout the mass, which when wetted will form a firm and hard surface. (17)

Rift (of Rock)—Quarrymen usually refer to the direction of easiest splitting as the "rift." See Fig. 8, and compare with "grain" and the "hardway."

Rock Asphalt—A porous rock which has become naturally more or less impregnated with asphalt or maltha. Some ex-

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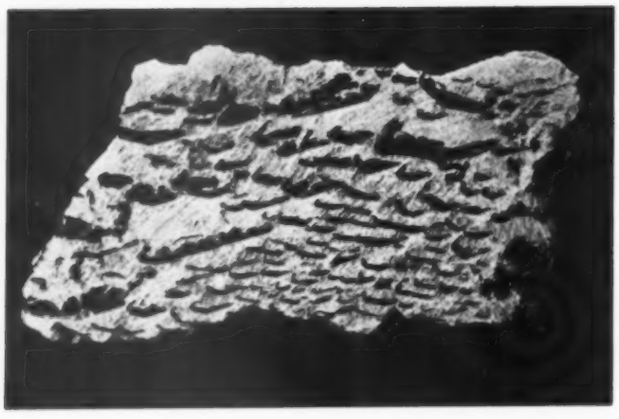

(*Photo by L. R. Morettl*)

Fig. 13—*Pegmatite, an Intergrowth of Quartz and Feldspar*

amples are Kentucky rock asphalt, and the Uvalde rock asphalt of Texas. See Fig. 15. (13)

Rock—A mass of material, loose or solid, which makes up an integral part of the earth. (1)

Rubble—Rough stones of irregular shapes and sizes, broken from larger masses either naturally or artificially, as by geological action, in quarrying, or in stone cutting or blasting. (2)

—S—

Sand—The fine granular material (usually less than ¼ inch in diameter) resulting from the natural disintegration of rock, or from the crushing of friable sandstone rocks. (2)

Sand-Clay (Road Surface)—A surface composed of a mixture of sand and clay where the two materials have been blended, so that their opposite qualities tend to maintain a condition of stability under varying moisture content. Some deposits are found in nature, but the bulk of such surfaces are prepared artificially. (17)

Sandstone—A typical sandstone is composed essentially of rounded grains of quartz, with or without interstitial cementing material, with the larger grains tending to be more perfectly rounded than the smaller ones. The fracture in sandstone takes place usually in the cement, leaving the grains outstanding, thus giving the rock the appearance and feeling of loaf sugar.

Sand-Seams—Quarry term for more or less minute veins or dikes of muscovite (white mica) with some quartz, in cases also with feldspar. (5)

Salt Horse—Quarrymen's term for aplite or other useless rock. (5)

Saprolite—Weathered (rotten) rock in situ. (3)

Sap—Quarrymen's term for ferruginous discoloration along sheet or joint surfaces. (5)

Schists (Rock)—Differ from gneisses in being of fine grain, and in possessing a well-marked tendency to split into thin layers, except when puckered or folded by movement subsequent to the development of schistosity. Some examples of schists are: mica schist, sericite schist, etc. (14)

Screenings—Broken rock, including the dust, of a size that will pass through one-half to a three-quarter inch screen, depending upon the character of the stone. (22)

Scoria—While lava is cooling, there is a constant escape of gases, mostly steam, and as these rise through the molten mass they make cavities, near the upper surface, that portion on the top often becoming frothy. If this solidifies quickly so that the gas cavities are preserved it is scoria. (1)

Seam—Quarrymen's term for joint.

Secondary Minerals—Mineral whose presence is due to the alteration of the original minerals. (5)

Sedimentary Rocks—Are formed by the decay of existing strata with subsequent deposition of the solid material that has been carried in suspension, by agencies of transportation to some point where they have been redeposited. (23)

Serpentine (Rock)—Refers to the soft greenish-colored rocks composed essentially of the mineral serpentine, or hydrous silicate of magnesia. (12)

Sericite—A more or less fibrous form of muscovite (potash mica), often resulting from the alteration of feldspar. (5)

Shale—A material composed essentially of silica and alumina, which has in addition a more or less thinly laminated structure. This structure has been imparted by the natural stratification of extremely fine sediments together with more or less pressure. (24)

Sheet Quarry—A quarry in which the granite lies in sheets, crossed by wide-spaced step joints. (5)

Shell—The term applied to oyster or clam shells which have been dredged from the seas and used for a road surfacing material.

Silt—Consists of the finer particles of rock substance and ranges in size from 0.05 to 0.005 mm.

Slate—Is rock, normally clayey in composition, in which pressure has produced a very perfect cleavage, so that a block of slate can be readily split into thin, smooth, tough plates. (12)

Slickensides—The polished and grooved faces of a joint or bed caused by motion and friction. (5)

Soapstone—Are rocks which usually consist of the mineral talc or some closely related mineral species. Talc is a hydrous magnesian silicate theoretically composed of 63 per cent silica, 32 per cent magnesia, and 5 per cent of combined water. (12)

Soil—A mixture of fine earthy material with more or less organic matter resulting from the growth and decomposition of vegetation or animal matter. (2)

Spall—A small piece or fragment broken from a larger piece of rock.

Stone—Any natural rock deposit or formation of igneous, sedimentary and/or metamorphic origin, either in its original or altered form. (2)

Stone Chips—Small angular fragments of stone containing no dust. (22)

Stone-Sand—Refers to the product (usually less than ¼ inch in diameter) produced by the crushing of rock. This material is usually highly processed and should not be confused with screenings.

Strain Sheet—Quarrymen's term for granite sheets produced by present compressive strain. (5)

Stratification (of Rock)—Is indicated by differences in composition, texture, hardness, cohesion and/or color of the rock disposed in parallel bands. See Fig. 12. (6)

Strike (of Rock)—Is the direction of the line of intersection of the plane of stratification with the horizontal plane. See Fig. 4. (4)

Stripping—The material (sand, clay, soil, etc.) overlying a rock of economic value, which must be removed before quarrying. (5)

Sub-grade—The upper surface of the native foundation on which is placed the road material or artificial foundation, in case the latter is provided. (22)

Fig. 14—*View of California Pumice, from Siskiyou County. Weight of Block About* 30 *Pounds, with* 20 *Per Cent Water Content*

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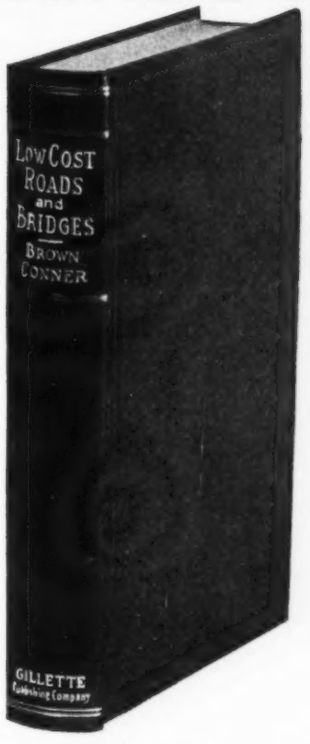

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Sub-joint—Minor joints diverging from or parallel to the regular joints. (5)

Sub-soil—The bed of earth immediately beneath the surface soil. (22)

Syncline—A geologic term for the trough part of a wavelike sheet or bed of rock. (5)

—T—

Tailings—Stones which after going through the crusher do not pass through the largest openings of the screen. (2)

Talus—A term used for the accumulation of fine, coarse, or mixed fragments and particles, fallen at or near the base of cliffs. See Fig. 16. (25)

Texture (of Rocks)—Is applied to the microscopic features, including the forms of crystals and the manner in which they are united. (3)

Till—A mixture of clay and boulders deposited by glaciers. (5)

Toenails—Curved joints intersecting the sheet structure, in most places striking with the sheets, in some differing from them in strike 45 degrees or more. (5)

Top-Soil (Road Surface)—A variety of surfacing used principally in the southeastern states, being the stripping of certain top-soils which contain a natural sand-clay mixture. When placed on a road surface, wetted and puddled under traffic it develops considerable stability. (17)

Tripoli—This is a leached or chemically deposited bedded sedimentary rock composed principally of chalcedony probably altered from chert or leached from limestone. The material is very siliceous. (21)

Trap (Rock)—Includes the dark-colored, fine-grained and dense igneous rocks composed essentially of the ferro-magnesian minerials, basic feldspars, and little or no quartz. The ordinary commercial variety of trap is basalt, diabase, or gabbro.

Trass—This is the specific name for a light colored volcanic tuff found in Germany. (21)

—V—

Volcanic Tuff—A tuff is a rock composed of the finer fragmental, consolidated ejecta from the explosive eruptions of a volcano. When a volcano erupts in this manner the surrounding rocks are shattered and hurled into the air along with the magma. The consolidation of the finer particles of this material forms the tuff. The color may be white, pink, brown, gray or yellow, sometimes passing into the darker shades. (21)

—W—

Weathering—The decomposition of a rock owing to the action of the weather. (5 and 26)

White Horse—Term used by quarrymen to denote a light-colored gneiss, aplite, or pegmatit. (5)

Wollastonite—A mineral consisting of silica 51.7 per cent and lime 48.3 per cent ($CaSiO_3$). It commonly results from the metamorphism of calcareous rock or marble where in contact with an igneous rock. (5)

—X—

Xenoblast—A term applied to crystals, in metamorphic rocks, which do not have their own proper crystal faces. (3)

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(Courtesy Uvalde Rock Asphalt Company)

Fig. 15—Sinking Drill Holes in Deposit of Uvalde Rock Asphalt, Texas

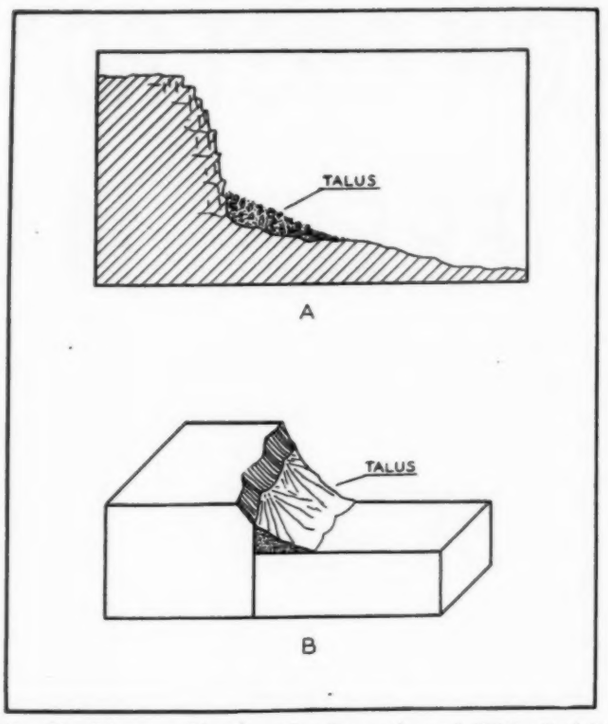

Fig. 16—Diagram Showing the Formation of "Talus." (A) From a Cliff, and (B) From a Fault Scarp (After Lahee)

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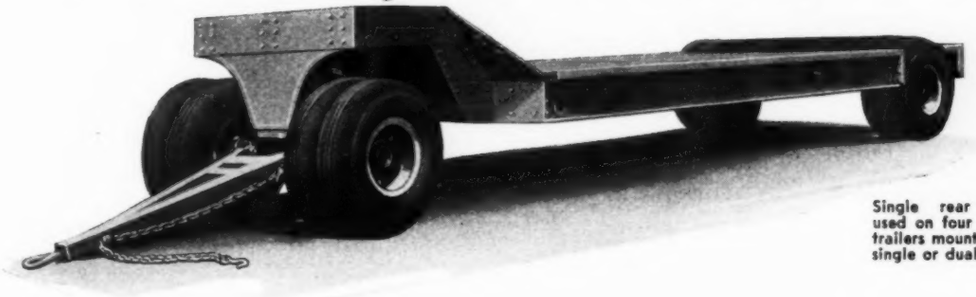

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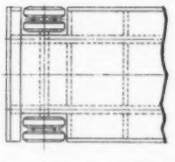
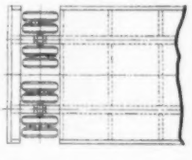
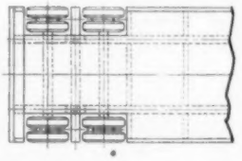


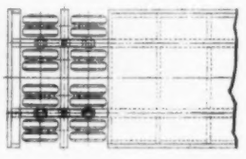
Single rear axle used on four wheel trailers mounted on single or dual tires.



Dual axles of the oscillating type used on six wheel trailers placed crosswise of the rear of the frame.



Tandem rear axles used on six wheel trailers are mounted on large rocker beams.



Multiple rear axles available in capacities from 25 tons up. Two oscillating axles placed in tandem and mounted on large rocker beams provide for the perfect distribution of load over all tires.

OBSERVATIONS BY THE WAY

By A. PUDDLE JUMPER

¶ One thing definitely lacking on highways in Virginia and South Carolina is the continuous center line. I felt lost at night, in both states, as I drove those highways where the "life line" was missing.

• •

¶ One of the fastest stretches of road I've traveled in the East is from Camden, S. C., to Raleigh, N. C.

• •

¶ South Carolina ought to do something about two antiquated bridges on U. S. No. 1. One is just south out of Camden—a terrible hazard. The other is just north out of Cheraw. The latter is a combination of a dilapidated covered wooden bridge and three spans of rusty, spindly, high trusses—also terrible.

• •

¶ Congratulations and compliments to South Carolina on her excellent state roads. Foresight was used when they were built.

• •

¶ North out of Raleigh, N. C., are miles and miles of roadside improvement that reminds me of the roadside development of boom-time Florida. Wonder what it's all about?

• •

¶ Another thing I wondered was the justification for building such an expensive bridge over Albermarle Sound in North Carolina. The bridge connects a small North Carolina town with two counties of swamps. Why the bridge? Incidentally, it was authorized under the last regime.

• •

¶ A representative of the West Virginia State Highway Commission invited me to visit the state and see the wonderful scenery. Of course I would see the roads, also. For the part that I traveled, especially from Charleston east on Route 60, I can compliment the state on its scenery. Ask me for my opinion on the road 10 years from now.

• •

¶ What beats me is how some equipment manufacturers all bid the same price for units at a state highway department letting. I wouldn't have believed it only I saw the figures. That's better, though, than cut-throat prices. A unit can be purchased on performance and cost per unit of output.

PURCHASING OFFICE MAD HOUSE

BY HELEN WERNER

Secretary-Clerk State Purchasing Department, Lincoln, Neb.

The purchasing agent took to his bed, he took to his bed with the flu,
And the purchasing agent's peccable clerk had the purchasing work to do.
The purchasing clerk she rolled up her sleeves and pulled down her vest and spat,
And down on the purchasing agent's chair with an air of aplomb she sat.
At the end of the day she was raving mad and they tethered her up in a cell
And these be the demons that chased her down, down to the jaws of Hell.

Baffles and slingers and shackles and shims, elbows and knuckles and nuts;
Collars and couplings and throttle shafts, eveners, axles and butts.
Spindle chucks, levers and shifter forks, tappets and ten-penny nails,
Pouring-cans, bushings and governor ball, washers and cams and pails.

Aggregate, oxygen, prestone, guns, masonite, tear-gas and mats;
Tractor disk harrows and grader blades, spreaders and sprayers and cats.
Beacons and torches and lumber and chains, lubricants, greases and glands,
Shrubbery, culverts and guard-rail posts, coal and cement and bands.

Distillate, cotton and trammel net, crack-filler, tents and maps;
Bearings and fresnoes and license plates, dynamite, plumb-bobs and caps.
Milk-testing bottles and steripads, breast-waders, half-inch rope,
Profile and plan sheets and rubber gloves, seine-webbing, anthrax dope.

"One full set of CORRECTION TOOLS"—Who are they for? I'll guess;
To straighten the brains of the dizzy lugs who ask me to purchase this mess.
"Grinder with belt that is TIGHT AND LOOSE"—(You can believe it or not);
One animatiphone, litmus strips, tar and a boiling pot.

Twelve hundred yardage of red percale, "For the field engineers" — did you say?
A bolt of gold ribbon, organdy, too, are the lads piecing quilts for their pay?
Rabbits and rags and rotary plows, barrels and bottles and bricks,
Guinea-pigs, goggles and gasoline, squeeges and sand and sticks.

Round and around went the mad parade. "Butterflies, worms and gears."
She was Somebody's Mother, boys, you know, be not ashamed of your tears.
This, gentle reader, is only a part, only a day at the game,
But the purchasing agent's ponderous clerk will never again be the same.

View of Slide on Ohio State Road along north bank of the Ohio River just southeast out of Cincinnati. Flood waters caused several of these.

¶ The weather in the Carolinas was certainly grand.

• •

¶ I say, Davis, old man, send me one of your North Carolina state highway town name and direction signs for a watch fob. No criticism on county road signs. Anyone who wants to drive on a county road knows where it is, anyway, but those state signs are so small one has to stop to read them.

• •

¶ You state equipment engineers—what do you do with your old equipment? I hope you cut it up for junk. I don't believe a state should try to cut prices by trading in old junk for more than its worth, on a new piece of equipment.

• •

¶ Just a word to compliment Virginia on the Lee-Jackson Memorial Highway. When construction, now in progress, is finished that road will be what the tourist hopes to travel. A scarcity of route markers is noticeable. There is too high a crown on some stretches, but I believe both of these deficiencies will soon be corrected.

• •

¶ Compliments to Virginia on the reflectorized traffic signs and buttons on guard rail posts on U. S. No. 1.

• •

¶ It's too bad that the Lee-Jackson Memorial Highway, U. S. 501, in North Carolina, has such a narrow surface. Good engineering was employed for the day when it was built, but the width is too cramped.

• •

¶ I wonder what sort of development South Boston, Va., anticipated when it built that wide, wide street north of town to meet the state's narrow pavement? It reminds me of the boom times in Florida.

• •

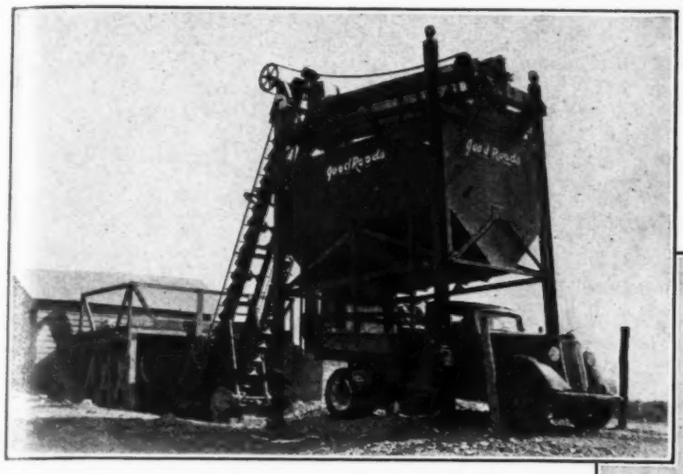
¶ Believe it or not—North Carolina has a strip of paving with lip curb. It's wide enough, too.

• •

¶ I see advantages of soil erosion prevention work done over U. S. 52 northwest of Indianapolis. In some places erosion control gutters were not carried far enough. This money was certainly well spent.

THEY'RE SAVING MONEY FOR THEIR OWNERS!

Good Roads Champion Semi-Portable Crushing and Screening Plants save money and increase profits by their large output, their low maintenance costs and their portability. Ideal for contractors, they can be taken to the job where there is native rock to be crushed or gravel to be sized. They cut material haulage costs and assure a controlled source of aggregate. Made up of famous Good Roads units, these plants are designed and constructed to meet the requirements of each purchaser, at no extra cost. For this reason, and because they are lighter to move, they have proved to be more economical than heavier standard portable plants. Write for Bulletin 4371-2.



GOOD ROADS
MACHINERY CORPORATION
KENNETT SQUARE, PA.

EMSCO *Cable Controlled* RIPPERS

Advanced yet practical design, rugged all-steel construction, and deep penetration make Emsco Cable Controlled Rippers ideal units for breaking up hardpan, shale, rocky or conglomerate formations, and heavy asphaltic pavements, so that the material can be handled more easily with bulldozer or scraper. Some of their highly advantageous features are: Proper spacing and slope of standards and points; tapered roller bearings in drum type wheels sealed against intrusion of dirt; heat-treated alloy steel axles; oversize rope sheaves mounted on heat-treated and ground sheave pins; and adjustable drawbar hitch. Made in two sizes and furnished with either three or five standards. Also furnished for hydraulic power.

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TRACTOR EQUIPMENT DIVISION
General Offices and Plant: 6701-7101 S. Alameda St., Los Angeles, California
Eastern Sales Office: 332 South Michigan Avenue, Chicago, Illinois

EMSCO
Cable and Hydraulic
TRACTOR
EQUIPMENT

Bulldozers — Trailbuilders
Rippers — Scrapers
Power Control Units

EMSCO

Looking west down the side of Blue Ridge Mountain, Virginia, U. S. 60. One can see three sections of road he just traveled. This new road is great and a piece of which Virginia should be proud.

¶ If you want to see a first class equipment repair depot of a state highway department, just stop off at Raleigh, N. C., and have Davis show you his pride and joy.

• •

¶ Jimmy Burch, Engineer of Statistics and Planning for the North Carolina Commission, wondered what would have happened if his boys on the Weigh Parties had been on U. S. No. 1 a day sooner than they arrived. A field artillery regiment was moving north on U. S. No. 1 and Jimmy wondered how his single state patrolman was going to hold the army at bay until the 150 trucks were all weighed and all drivers interrogated. Suppose the march was a secret maneuver; I'm afraid Jimmy would have had an unfinished report which he would have filled out as—estimated.

• •

¶ Visited the Raleigh Engineers' Club. At the meeting new officers were elected. A movie by the Dept. of Interior of the United States on Boulder Dam construction was shown. One does not realize the magnitude of that project until the pictures are seen. Retiring president of club, Mr. J. M. Fontaine, carried on after Mr. J. M. Peedin, new president, was elected. Over 30 members were present.

• •

¶ I wonder why Hoover's name is never mentioned in connection with Boulder Dam. As I recall the project was named Hoover Dam at the start. It is one of ex-Pres. Hoover's self-liquidating loan projects. Look's like pretty small politics to me. A moving picture is a matter of record, of history.

On North Carolina No. 7, Gaston County, between Gastonia and Kings Mountain, showing side drains for taking water off shoulder of road. On the new route, which is paved with P. C. concrete pavement, many fills are protected in this way.

¶ I imagine there are elaborate plans on record to beautify the roadsides of the Lee-Jackson Memorial Highway in Virginia and North Carolina. It needs this kind of attention.

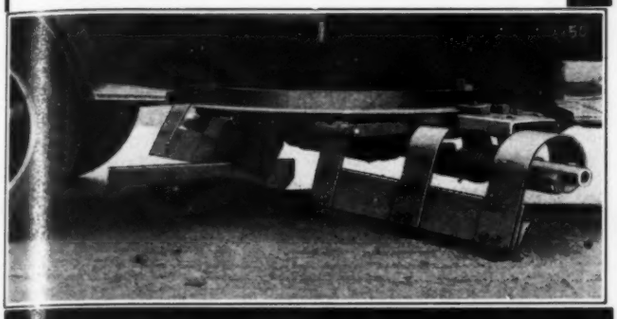
Another view on North Carolina No. 7 in Gaston County. Note terrace ditches in foreground for removing water

Note the corrugations on this bituminous surface treatment on U. S. 40 in Maryland. Bob Reindollar don't believe in advertising "SLIPPERY WHEN WET" paving. He corrugates the surface and it works. I, also, feel bad when I see those signs along the road—SLIPPERY WHEN WET. Why advertise our failure to do a right kind of job?

• •

¶ It's a pretty good sign that "sprig has cub" when you see maintenance crews cleaning out culverts and side ditches. Indiana crews were active as I went through the state.

SHOULDER MAINTENANCE



● BANISH that dangerous rut along the edge of pavements by the use of the Root Hydraulic Double Cylinder Shoulder Maintainer. Light trucks equipped with this attachment quickly correct this very dangerous condition, leave a straight grass line, and give perfect drainage.

Make driving on your highways a pleasure by removing this one serious hazard. Write for further information.

● ROOT SPRING SCRAPER COMPANY

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ON THE JOB

Your tools and records have a safe place out on the job when you use the LB HanDeeBox. All steel construction; covers locked full length of box with one lock. You can store all the tools your crew needs in this safe, long lasting, fireproof, trailer type box. Write for full data, now.

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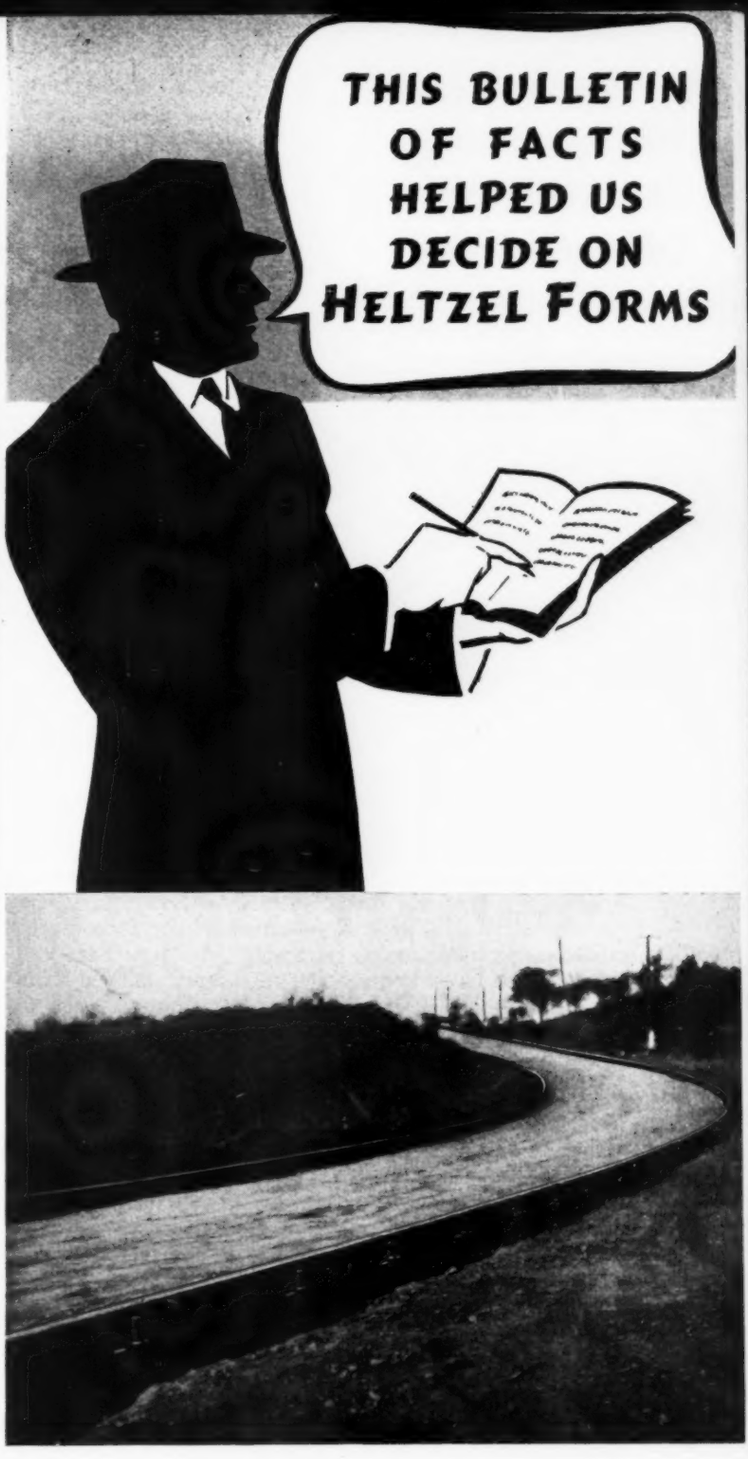


"Take our 40-mile Claremont job last summer. We expected to run into hard luck on the time element, and allowed for it just like the outfits who bid against us. Of course, *we* figured on our Heltzel Forms. Well . . . they ironed out all the trouble. We just set 'em with a couple of licks, yanked 'em up and set 'em again—ran our heaviest road machinery on 'em and treated 'em mean all around. We *moved*—finished up 65 days ahead of schedule. And those Heltzel Forms are good as new!"

Let us send you our Road Form Bulletin, No. 101. It points the way to *better work at lower cost*. Write for it today.

THE HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO

EDITORIAL

Wide Open

THE present status of unemployment compensation procedure might be compared to a steam locomotive racing down a stretch of track and not pulling a single coach or car. All effort has been directed at how to make the engine go, the engine being the tax producing power, and little or no effort has been directed toward hauling coaches, hauling coaches being the carrying of men through stretches of unemployment. In other words, an attitude of "get-the-dough" has prevailed rather than an attitude of how to compensate the unemployed man. The anomaly of the situation is evident when it is recalled that the basic purpose for which these laws were passed has been practically neglected, perhaps forgotten. The whole question of benefits to unemployed has been left wide open.

An example; a contractor's headquarters are in Chicago. He has a highway grading job in Indiana, a street paving job in Kentucky and another grading job in Mississippi. Unemployment compensation procedure developed so far has dwelt heavily on how and where the contractor shall pay his state unemployment compensation tax. Little or no workable procedure has been developed to pay compensation to the unemployed man. For some of his skilled men who left Chicago to go to the Indiana job, the contractor is in a difficult position in justification to them, as matters now stand because Illinois, his headquarters, and the place from which technical and skilled employees will be reported, has no state unemployment compensation law. Upon completion of the Indiana job the Chicago key-men move onto the Wisconsin job which the boss just "bid off," except one, who desires to remain in Indiana. If procedure and matters remain as they now stand, this man has no protection against unemployment losses. Until he can get another job he wishes to file for unemployment compensation. Where shall he do it? Indiana? No; he was reported from Illinois. Illinois? No; she has no unemployment compensation law. The federal government? No; the federal government does not pay benefits even though it collects a tax.

It is possible that the eventual transfer of unemployment compensation funds between states for employes moving from one to another may be worked out like bank clearings.

Massachusetts and Rhode Island expressly provide for discharge of benefit obligations to an employe moving out of the state, by a lump sum payment of not less than 50 per cent nor more than 80 per cent of the maximum amount of benefits to which his past weeks of employment might entitle him. Lump sum benefits shall be paid in those states, however, only in unusual cases, as when an employe has no prospect of securing further employment in the locality but may secure employment elsewhere.

Knowing these facts to exist, it would not be surprising to hear that this contractor is studying hard to find ways and means for circumventing the law. Social Security legislation so far has been a one way operation, an engine running loose and equipped with automatic stoker; a powerful machine for getting tax money and no semblance of obligation of that money.

The contractor, as an employer, does not object to paying a tax that all other employers pay, so long as he knows there is a benefit to be derived from that tax and the benefit explicitly provided in the same law setting up the tax. But when he sees all energy put forth in preparation of rules and regulations for getting his money as a tax and the question of benefits for which the tax is being paid is left wide open, he begins to think. He wonders if the engine should not haul some coaches, be controlled by an engineman and be equipped with a headlight to show the engineman the way through the darkness of unemployment.

▼

Road Program Foresight

YOU recall that you stood at the window and watched the outdoors. You were only five years old. One minute the sun shone and the next minute it was raining. You were discouraged because mama said you must stay in out of the rain. You wanted to play outdoors. To you, life seemed at its very end. The next moment your interest heightened and you were driving on a pinnacle of enthusiasm. Now you are grown up. You rarely experience the thrills of childhood experiences and you rarely drop to the apparently bottomless depths of despair. You are forty or fifty now.

You know life is not all rosy, all ice cream and cake. Neither is it all worry and despair. One of the differences between you as the baby and you as the grown-up is your ability to sense valleys and crests of life's activities.

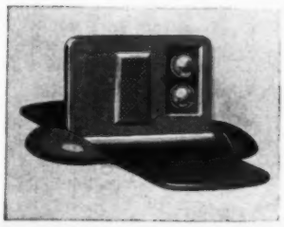
As a grown-up you put screens on your house in the spring, you carry a rain coat on a trip out of town; you sleep longer on Sunday to prepare for Monday's big job; you buy a fur coat for your wife in the spring or summer rather than wait until winter comes; you save for a rainy day while your health is holding up. All of these are examples of foresight, that characteristic which distinguished you the man from you the baby; that characteristic that allowed you to sense the valleys and crests of life's forward march.

Some men have more of this faculty than others. If they are the executives or administrators of road and streets programs, their states, counties, or cities profit accordingly. The better their foresight, the farther they become removed from the characteristic variations of childhood emotions; the better balance wheel they become for orderly road and street program developments.

Time is now at hand when foresight is needed on the question of state supervision of county road work. The policy of the state taking over jurisdiction of all county roads demands analysis. In Virginia, the state highway commission would like to get out from under the county road load. In North Carolina, the adjoining state on the south, the state highway commission does not consider jurisdiction of all county roads to be a burden. Conditions in both states are similar so far as past development and classifications of roads are concerned.

This is a place where foresight should be employed. We wonder if the characteristics of childhood haven't governed actions rather than the characteristics of grown-ups.

YOU CAN'T GO WRONG WITH LIFE LINE TRAFFIC MARKERS



Life Line Traffic Markers are on the Job 24 Hours per day. They are highly visible in daylight and at night. Their visibility increases. They are unaffected by dust, rain, sleet or fog and command attention in any weather.

The Life Line System fills the need for an Efficient Day and Night Road Marker at a Very Low Cost.

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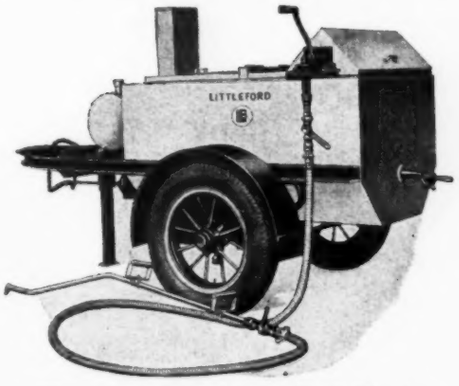
3088 West 106th St., Cleveland, Ohio

A FASTER HEATER



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Crescent Scraper making long cut-and-fill for bridge approach.

YOU can turn from one excavating job to another—from making cuts and fills to stripping overburden, from gravel pit work to stockpiling, from cleaning reservoirs to digging basements—and handle all these jobs at the lowest cost per cubic yard with a

CRESCENT SCRAPER

A Crescent Scraper bucket in operation gives the impression of accomplishing so much with such little effort. It starts to gather its load the instant it is pulled forward, filling to capacity within a few feet of travel; then it ceases to dig and simply "rides" its load across the surface. When the bucket reaches the designated dumping point the operator just moves two levers on the power unit to cause the bucket to discharge its load and return to the loading point at high speed. Yardages up to 600 cu. yd. per hour are hauled 100 to 1,000 ft. or more for a few cents per cubic yard.

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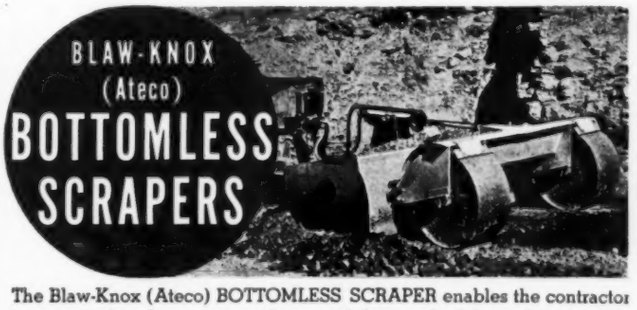
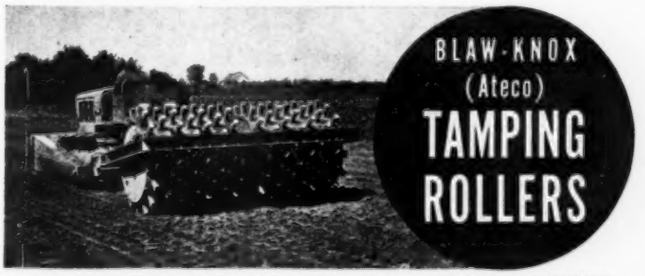


The Blaw-Knox (Ateco) BOTTOMLESS SCRAPER enables the contractor to operate his dirt moving job on a definite schedule and at a profit. It keeps dirt moving costs down.



Tamp as you roll with a Blaw-Knox (Ateco) TAMPING ROLLER, a remarkably efficient and economical device for compacting heavy and light earth fills of every description. Meets requirements of all State and Government specifications.

Send for descriptive catalogs

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Please send:—CATALOG No. 1540—Blaw-Knox (Ateco) BOTTOMLESS SCRAPERS . . . ☐

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EQUIP YOUR TRUCK FOR PROFIT

...put in MORE GEARS for REAL PERFORMANCE

20% LESS FUEL
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23% FEWER R.P.M.'S
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52% MORE POWER

A good engine is badly handicapped without the right *gear ratios* to properly transmit its power. There is no point in equipping your truck with a trailer, third axle and overload springs if you don't add *extra gear ratios* too! For real performance you need *more gears* and plenty of *gear ratios*. A Watson-Brown-Lipe will give your truck *12 forward speeds*. It will pay for itself quickly—then *it will pay you!* From the minute it's installed you'll know you have the most efficient helper unit you can put in a truck.

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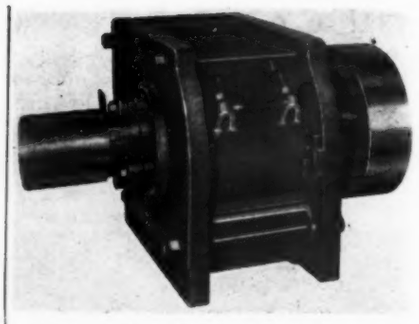


Swing Hammer Pulverizer

NEW EQUIPMENT AND MATERIALS

New Pulverizers

A new swing-hammer pulverizer of the New Holland Machine Co., New Holland, Pa., is designed for reducing non-abrasive material to a fine product by using rapidly revolving hammers.

The main frame is dovetailed together and held rigidly in place with heavy frame bolts. A large hinged door on the rear provides easy access to the screen bars and hammers for removal or adjustment. When the door is closed, two heavy adjusting bolts hold the screen bars rigidly in place. The hammer head consists of two heavy full steel disks with long hubs keyed to the drive shaft with two series of hammer pin holes for adjustment for wear of hammers and screen bars. The main drive shaft is 2½ in. in diameter, high carbon steel, and runs on high grade roller bearings in dustproof housings.

Hammers are square faced, manganese steel, and balanced for pulley speed to prevent vibration. The hammers are suspended close to the bearings to prevent springing of the drive shaft under heavy duty service. Hammer pins are high carbon steel and are held in place with a cover plate. No cotterpins to shear or wear off. A convenient door on the side permits easy access to the hammer pins for removal or reversing the hammers. The hammers are reversible, interchangeable, and adjustable for wear.

The screen bars are manganese steel. Spacers regulate the size opening between the screen bars and are available in 1/16, ⅛, ¼, ⅜, ½, or larger, as may be required. A heavy flywheel supplies the momentum necessary to carry the rotor over the peaks in the load, preventing belt or motor trouble. The swing hammer pulverizer is mounted on channel sills or on a 4-wheel steel truck with or without elevator and spout.

New Air Compressor

The Sullivan Machinery Co., 307 North Michigan Ave., Chicago, Ill., has brought out a new line of "V" vertical air compressors designed particularly for construction, tunneling and mining where air capacities greater than obtainable from portable compressors are desired. Known as the WN-102 series, these compressors are available in three sizes: 445, 550 and 720 cu. ft. for minute actual air delivery (displacement 536, 660 and 856 cu. ft. per minute). The design is 2-cylinder "V" type, 2-stage and double-acting. These compressors are extremely compact and can be moved from one job to another by truck or trailer. Each size is self-contained and requires no water service connections for cooling.

New Sullivan Air Compressor

Any type of drive—direct connected, "V" belt or flat belt—can be used with Diesel or gasoline power units or electric motor. Either complete units consisting of compressor and power unit on skid type bases or the compressor only can be supplied.

Qualities stressed by the manufacturer are smooth running balance, maximum

power economy, precision construction throughout, ability to give reliable service over a long period of life, ease of transportation, and minimum set-up expense. Some of the distinctive features of design are ball main bearings, complete force-feed lubrication, special alloy honed cylinder liners, special alloy honed crosshead guides, unusually efficient, long life air valves, water and dust tight crank case, and precision type connecting rod bearings.

▼

New Federal Trucks

Six new conventional trucks and four new cab-over-engine trucks, all specifically designed for tough trucking work, have been announced by the Federal Motor Truck Co., Detroit, Mich.

In designing these trucks Federal engineers have taken into account that certain truck operations are so severe that a design departing from the more or less standard units must be provided.

Six oversize models have been added to Federal's conventional line of trucks. These include:

	Rating, tons
Model 15H	1½—3
Model 18H	2 —3½
Model 20H	2 —4
Model 25H	2½—4½
Model 29H	3 —5
Model C8H	7½

To Federal's line of cab-over-engine trucks four new oversize models have been added, as follows:

	Rating, tons
Model 75H	1½—3
Model 80H	2 —4
Model 85H	2½—4½
Model 89H	3 —5

Larger rear axles, rear springs, rear brakes, universal joints and tire equipment constitute the chief changes in the new oversize series.

▼

New Portable Conveyor

A new portable conveyor has been announced by the Atlas Conveyor Co., Clintonville, Wis. The new contractors' and highway builders' machine is 24 ft. long and is equipped with a Stover 2-cylinder radiator-cooled engine mounted above the frame. Equipped with high pressure pneumatic truck tires, the conveyor can be towed easily behind a modern truck at high speed. Another feature claimed is its being so flexible that it can handle a variety of jobs—in coal and material yard work, gravel pits, on highway construction work, and even in excavating operations. The new conveyor is built in only one belt width and length, but special lengths are made to order.

▼

Bucyrus-Erie Changes Seattle Office

The Seattle office of the Bucyrus-Erie Co., South Milwaukee, Wis., is now located at 3408 First Ave., South, Seattle, Wash.

"Performance"—your best Salesman

Users of Littleford Model "C" Pressure Distributors say that the better type of job they can do—the superior *performance* of their Model "C" distributors—sells itself to their customers—enables them to get more work, at a profit.

Now, we do not claim that you will have a monopoly on all the application work in your bailiwick the instant you start using a Littleford Distributor.

But! — We do guarantee you that the new Littleford Model "C" gives you many mechanical advantages. It is simpler and easier to operate. Faster, safer heating. Instant cut-off without dribbling at the spray bars. Accurate Application.

In short, this New and Modern Distributor is a premium model at no premium in cost. Premium Performance at regular prices.

Ask for the new Bulletin M-14, today.

BLACK TOP ROAD MAINTENANCE EQUIPMENT — LB — SINCE - 1900

LITTLEFORD

LITTLEFORD BROS.
454 EAST PEARL STREET
CINCINNATI, OHIO

New Atlas Portable Conveyor

ETNYRE "NON-DRIP" Circulating SPRAY BAR !

GREATEST IMPROVEMENT EVER MADE IN DISTRIBUTORS !

● WHEN Etnyre engineers perfected the "Instantaneous Shut-Off" Spray-Bar, eliminating the uncertainty of "suckbacks," a most annoying problem was solved for Contractors and Highway Depts. It prevents "dripping or slobbering" on highways, intersections, cross-walks, etc. A clean cut starting and finishing line is positively assured by the Exclusive Etnyre valve-at-nozzle control of flow of material. *Only* in Etnyre Distributors—*largest selling, most widely used in the world*—can you get this great Bituminous Distributor feature. No clogging or congealing of materials—asphalt, tar, road oil, emulsion—in the Etnyre "Leakless Valve" Circulating system. Positive accuracy—simple, easy operation—full width distribution—superior *double* burner heating system—powerful rotary precision pump are other outstanding features of these famous distributors. Send for NEW catalog No. 506-A for complete information.

E. D. ETNYRE & CO.
OREGON, ILLINOIS

DEALERS IN ALL PRINCIPAL CITIES

New Subgrader

Uniformly accurate and compact subgrade at high speed and low cost is the manufacturer's claim for the machine recently placed on the market by the Flynn Manufacturing Co., 512 Guaranty Bank Bldg., Alexandria, La. Powered by a 6-cylinder 66-h.p. Wisconsin motor, the subgrader travels under its own power on the road forms on ingenious crawler treads which dissipate the load over a wide area of road form so as to obtain positive traction without danger of overload.

Subgrade cutting is done at any of three forward speeds ranging upwards to 14 ft. per minute, the excess earth being carried beyond the formline on both sides of the road simultaneously through light conveyors. Cutting is done by a high-speed revolving cutter operated in an overcutting manner and fitted with wear-resisting teeth which may be set to any contour.

A truck-overpass (as shown in the illustration) is provided where trucking is done on the grade and is so designed as to permit passage of trucks without any interference with continual forward operation of the subgrader. Wagon is provided for transportation between jobs, having tiltable frame and full circle turn with tractor hitch.

The subgrader may be used readily on subgrade treatment and stabilization work, for either cushion or admixture treatment. For these purposes the revolving cutter is lowered to the required depth below the forms, and cutting, pulverizing and mixing (in admixture work) are done at one operation.

The Flynn Subgrader, Showing Truck Overpass

Emsco Now Manufacturing Complete Line of Cable and Hydraulic Controlled Tractor Equipment

Bringing together a number of newly developed units and a line of equipment already well known to the construction world, Emsco Derrick & Equipment Co. of Los Angeles now manufactures a complete line of cable and hydraulic controlled tractor equipment. Comprising the Emsco line are the widely used models of bulldozers, trailbuilders and power control units formerly produced by the Hutchins Winch Co., and the new Emsco-developed hydraulic equipment.

The Emsco cable-controlled trailbuilders and bulldozers are built for all popular size track-laying tractors. This equipment embodies outstanding Emsco features, among which are an exclusive patented tilting action that permits extraordinary speed in tilting the blade for casting to either side; design that prevents any load reactions on the tractor's main frame or springs, and moldboard of correct size and contour for maximum pay load.

In the Emsco bulldozer, as with Emsco trailbuilders, the design is such that no load is placed on the tractor transmission case main frame or equalizing springs. Loads are carried through side frames to dead axle spool of tractor, leaving drawbar available for other equipment. Another major feature is lateral blade tilt of from 12 to

Buckeye

50 Clipper

with METERED VACUUM CONTROL

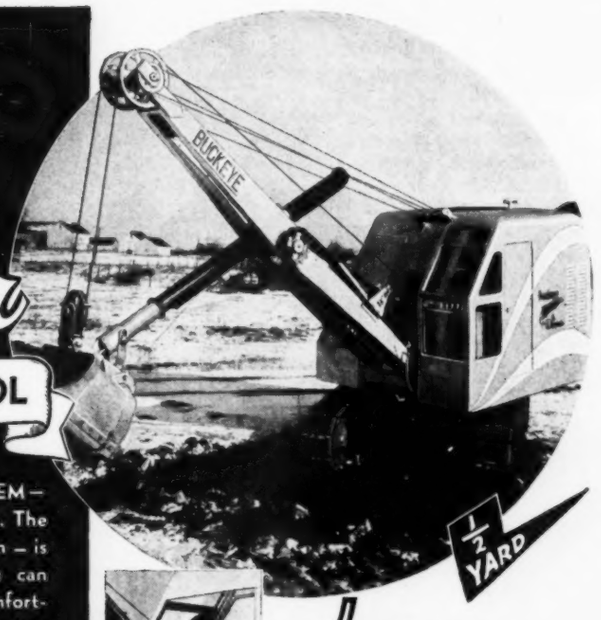
OPERATES AS EASILY AS DRIVING A CAR.

Every operation is maintained by a METERED VACUUM SYSTEM — never affected by temperatures, small leaks or water in the lines. The touch and feel of each lever — so essential to accurate operation — is there. All operator's movements are practically effortless. You can swing, travel and hoist simultaneously. The Clipper has a big comfortable seat with thick cushion and a padded back rest, a hot water heater. The handiest, most comfortable cab on any machine, with full vision safety glass windows — and it has METERED VACUUM CONTROL.

Send for literature or arrange to see the Clipper before you buy any ½ yard excavator this year.

Convertible

SHOVELS • CRANES • TRENCH HOES • CLAMSHELLS • DRAGLINES



As easy as driving your car!

THE BUCKEYE TRACTION DITCHER CO., - - - - FINDLAY, OHIO

15 in. Blade adjustment can be made by the operator in a few minutes.

All Emsco cable-operated units are powered by the highly efficient Emsco power control units, which are manufactured in both single and double drum types.

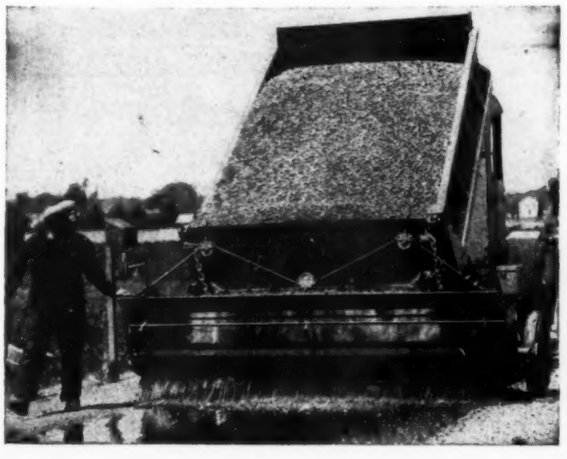
Like Emsco cable-operated units, Emsco hydraulic controlled equipment has been thoroughly service-proved. For 18 months prior to putting several of the hydraulic units on the market Emsco engineers carried on intensive experimental and development work and field tests, and are continuing the same policy with forthcoming units.

Manufacture and sale of the Emsco line of construction machinery, which includes rippers and scrapers in addition to bulldozers, trailbuilders and power control units is in the hands of a special tractor equipment division of the company with offices at 332 S. Michigan Ave., Chicago, and 6701 S. Alameda St., Los Angeles, Calif.

▼

New Mechanical Spreader

A new mechanical spreader brought out by the Good Roads Machinery Co., Kennett Square, Penn., is easily attached, extremely simple in operation, and is built to give years of trouble-free service. With it, material can be spread in strips ranging from 6 in. in width to 9 ft. The quantity of material passing through the spreader can be easily regulated by means of a sliding gate with control located on the end of the hopper. Aggregate is kept flowing through this gate by a spiral agitator bar which extends the length of the hopper and is kept turning by means of a floating traction wheel. This traction wheel can be easily switched from one side of the spreader to the other, so that the machine will operate when the truck is either backing or going forward. The N & H spreader will fit any truck and can be attached by one man in less than one minute. Bulletin describing the machine will be sent upon request to the Good Roads Machinery Corp., Kennett Square, Penn.



The New N & H Spreader

New Motion Picture on Hard-Facing

A new motion picture on hard-facing, which shows in detail the process of adding wear-resisting surfaces to steel parts, is now available for showing the interested organizations or groups. This highly instructive motion picture has been produced by Haynes Stellite Co., 205 East 42nd St., New York, N. Y., a unit of Union Carbide & Carbon Corp., and can be obtained for showings through representatives of either Haynes Stellite Co. or the Linde Air Products Co.

New 5/8-Yd. Shovel

The Northwest Engineering Co. has announced a new 5/8-yd. shovel. This new machine will be known as the Model 20. It is fully convertible from shovel to crane or dragline by simply changing booms. The outstanding characteristic claimed for this unit is speed. Every effort has been made to assure fast action in all functions. Its design is very similar to the recently announced Northwest Model 25. Bases are of cast steel. Side frames are cast integral with the rotating base. Travel gears are fully enclosed and the whole crawler design is engineered and built exclusively for shovel service.

New Northwest Model 20 5/8-Yd. Shovel

The "feather-touch" control and the cushion clutch are standard equipment. Swinging clutches are of the cone type . . . smooth acting, non-grabbing, and cool running. Ball or roller bearings are used on all the high speed shafts. The power take-off is through helical gears running in oil in an oil-tight housing.

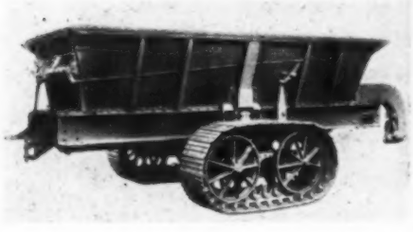
The machine will regularly be furnished with a Wisconsin 6-cylinder gasoline engine; however, electric or Diesel power is available. The shovel equipment will be the standard Northwest welded dipper stick equipped with a manganese 5/8-yd. dipper. A full cab is standard equipment. All operating parts above the deck are accessible within this cab.

▼

New 18-Yd. Bottom-Dump Trailer

A new 18-yd. bottom-dump trailer has been announced by the Athey Truss Wheel Co., 5631 West 65th St., Chicago, Ill.

Embodying all of the tested features of previous Athey forged-trak bottom-dump trailers, the new trailer is built to carry capacity loads wherever track-type tractors can operate. The axle and drawbar are spring-mounted to absorb loading and roading shocks. There is a simple, positive, mechanical windup. The construction of the entire unit is exceptionally rigid for heavier loads.



New Athey Forged-Trak Bottom-Dump Trailer

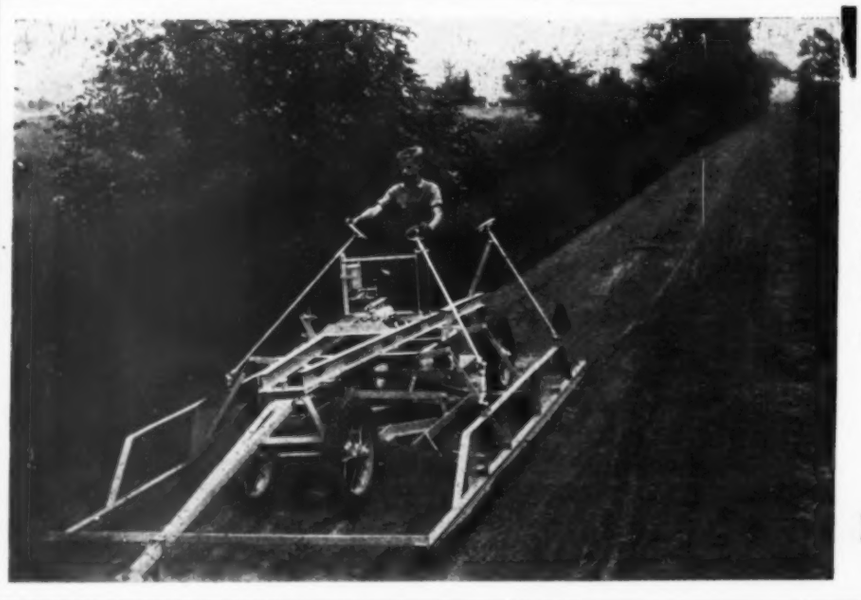
WITH THE MANUFACTURERS

Tranter Co. Now Distributor for Continental Motors

Continental Motors Corp. of Detroit, Mich., has announced the appointment of the Tranter Mfg. Co. of Pittsburgh as their distributor for industrial engines for the territory of Western Pennsylvania. The Tranter Co. recently celebrated its centennial, thereby joining the select group of Pittsburgh concerns which enjoy a record of 100 years of successful business activity. Henry Tranter, president of the Tranter Co., points out that this concern has pioneered the merchandising field of gasoline engines and has consequently acquired the finest of facilities for service.

▼

"THAT'S MY BABY," proudly acclaims Jack B. Haile, general manager of the road-machinery division of Gar Wood Industries, Inc., as he admires the miniature Gar Wood hydraulic scraper. This "pocket-edition" is an exact, scaled-down replica of the actual scraper—a road-building machine—and operates hydraulically just like its big brother, shown alongside. The diminutive Gar Wood hydraulic scraper is now on a circuitous, nation-wide tour to demonstrate its features to track-type tractor dealers located throughout the United States.



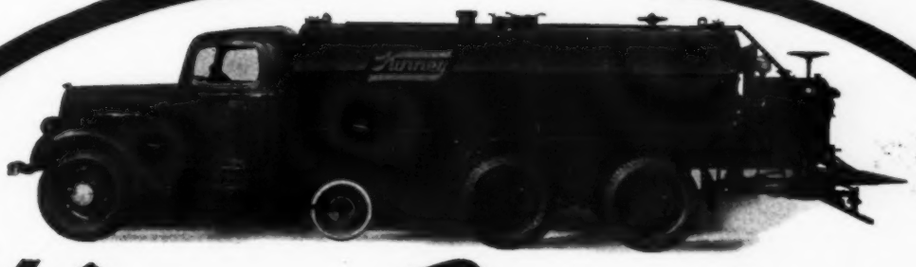
THE GLEDHILL ROAD SHAPER

The Gledhill Road Shaper creates a sensation in road maintenance, stabilization work, and spreading bladeable blacktop materials.

Write for further details!

Distributors and Salesmen Wanted!

The Gledhill Road Machinery Co.
GALION, OHIO



Kinney Distributors

come *complete*, ready to go to work, no extras to buy

. . . apply more evenly and accurately . . . load, travel, unload faster . . . stay on the road more days per season . . . have a safer, better heating system. Heavy Duty; All-purpose, and General Service Models. Also 2 Junior Models for light trucks.

Write for Bulletin A.

Kinney Plain and Steam-Jacketed Pumps—Bulletin 14

KINNEY
MANUFACTURING CO.

3537 Washington St. Boston, Mass.

NEW YORK 30 Church Street
CHICAGO 1202 Buckingham Bldg.
DALLAS 808 Santa Fe Bldg.
PHILADELPHIA 725 Commercial Trust Bldg.
LOS ANGELES 1333 Santa Fe Avenue

You'll find ALL THREE in the MICHIGAN Truck Shovel, with convertibility and economy in the bargain! 25 mph. on the hiway, with ordinary truck economy is MOBILITY plus . . . Seasoned engineering and heavy duty construction spell DEPENDABILITY . . . And for operating speed and ease, MICHIGAN'S finger-tip AIR CONTROLS have no equal . . . The MICHIGAN quickly converts to crane, trench hoe, clam or dragline.

This popular 3/8 yd. shovel fully described in Bulletin "RS", Write:

MICHIGAN POWER SHOVEL COMPANY
Benton Harbor, Michigan

EXTRA
Powerful!

MULTIPLE ROPE BUCKET

•

Double Hinge construction permits a longer spread of the open bucket and greater rigidity for hard digging.

•

Write for new bulletin.

THE WELLMAN ENGINEERING CO.
7020 Central Avenue Cleveland, Ohio

WILLIAMS
POWER-ARM, POWER-WHEEL, MULTIPLE-ROPE, DRAGLINE ..... buckets

WE

- We cut your costs and save time and money.
- WE control equipment unobtainable elsewhere.
- WE render unequalled service.

BREAK

- WE specialize on difficult jobs BREAKING & BLASTING.
- WE have most modern equipment.
- OUR trucks go anywhere.

CONCRETE

- Trenches — Roads — Foundations Building Alterations — Railroad Work and Heavy Engine Foundations.

CONCRETE CUTTING CORP. OF AMERICA
52 Clark Street • Brooklyn, N. Y.
Mfrs. Rapid Pavement Breakers.

Allis-Chalmers Opens Million Dollar Plant Addition at Springfield, Ill.

The greatest sales conference and equipment show ever conducted by Allis-Chalmers Manufacturing Co. was held March 18, 19 and 20 at Springfield, Ill., with 700 dealers, dealer salesmen and company men in attendance. The occasion was the opening of a new million-dollar addition to the factory at Springfield, which doubles the company's production capacity on track-type tractors.

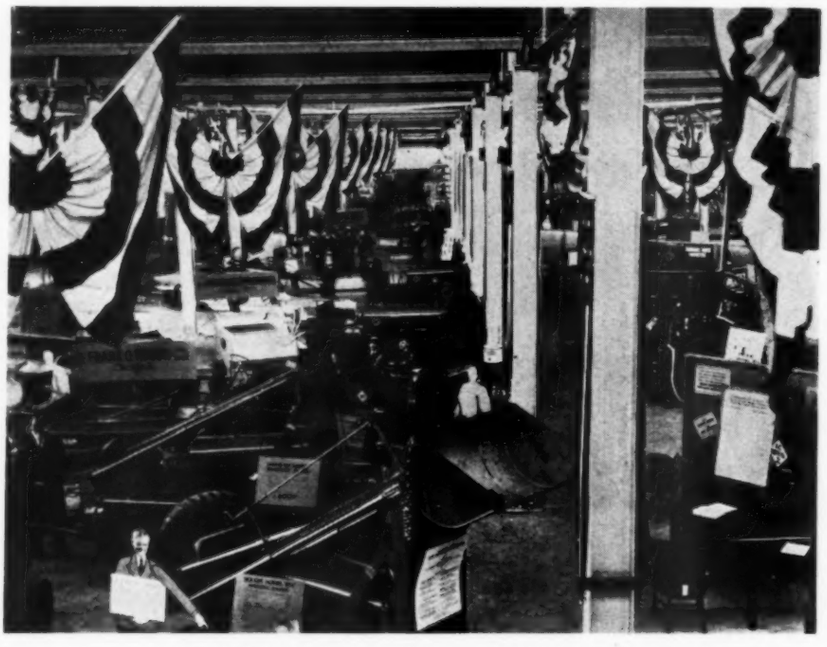
A half-million dollar display of Allis-Chalmers tractors and allied equipment was one of the high-lights of the meeting. The display occupied more than 30,000 sq. ft. of space. In addition to a complete line of A-C track-type and wheel-type tractors, speed patrols, blade graders, power units and speed ace hauling units, the exhibit included more than 100 units of allied equipment to work with the tractors. A veritable "who's who" of allied equipment manufacturers participated—each explaining and demonstrating the particular advantage of his equipment to an enthusiastic audience of dealers and salesmen.

Of special interest was the company's new 64 H.P. Model "S-O" controlled ignition oil tractor. Its features include higher speed—up to 6.37 miles an hour, constant mesh transmission, truck-type gear shift, roller bearing tracks and controlled alignment of tracks. Complete allied equipment for this model was included in the display.

Some of the allied equipment shown with the various tractor models included: Continental 2-wheel scrapers; Gar Wood and Ateco 4-wheel scapers; Baker bulldozers, gradebuilders, road discs, road rooters and snow plows; Century "35" dual control grader; Gar Wood bulldozers and road-builders; Ateco hydraulic or cable road-builders, cable hoists and sheep's foot tampers, Blaw-Knox bottomless scrapers; Knapp hydraulic scrapers, rippers, hydraulic pumps and dump bodies; Isaacson towinch and winchoists; "Silent Hoist" power swing boom crane and drum winches; Hughes-Keenan roustabout crane; Harnischfeger "V" type sidewalk snow plow; Hough loader-digger and transport buggy; Carco yarders, single and double drum hoists and roadbuilders; Tracks-n pipe boom and wagons.

Each day of the convention, on a nearby "proving grounds," tractors and allied equipment demonstrated their dirt moving ability.

The new plant addition is modern in every respect and is well equipped with the latest, most efficient tooling and machinery. Four production lines are now in operation, one for each of the "L," "K," "S" and "M" models.



Part of the Display of Tractors and Allied Equipment

Blaw-Knox Acquires Power Piping Co.

The Blaw-Knox Co., Pittsburgh, Pa., has acquired the property and business of the Power Piping Co. of Pittsburgh, W. P. Withrow, president of the Blaw-Knox Co., announced. The Power Piping Co. was organized in 1916 and has been engaged in the design, manufacture and erection of piping for power plants, oil refineries, sewage plants, water works and industrial plant usages for all pressures and purposes. In 1934 it added a sprinkler division, and the company has been a material factor in this industry since that time. In 1932 new, modern fabricating machinery and bending equipment was installed to increase production. The business will now be operated under the name of "Power Piping Corporation." Mr. William V. Quartz will continue in charge. In commenting on the transaction Mr. Witherow said: "There is every evidence of a marked improvement in the type of construction work in which Power Piping Corporation is engaged, and this business, being closely related to some of the present activities of the Blaw-Knox Co., permits it to widen and diversify its activities in line with its policy."

"Quick coupling and uncoupling allow for MORE TRUCK TRIPS—"

One state highway official says the advantage of the simple, rugged, quick acting coupling device is just one of the reasons why he prefers the Buckeye Spreader. It saves valuable truck time, speeds up the job and reduces the number of trucks required.

But most important — the Buckeye Spreader places any surfacing material exactly where wanted, and in accurate amounts per square yard as called for in the specifications.

Get all the facts — investigate the Buckeye before you buy any surface material spreader this year.

BID THE Buckeye WAY • ask for our operation data before you bid

Buckeye Surface Material SPREADER

THE BUCKEYE TRACTION DITCHER CO.
FINDLAY, OHIO

Killefer road equipment

Revolving Scrapers
Revolving Rippers
Regular Rippers
Road Discs, or Planers
Compacting Harrows
Oil-Mix Cultivators
Ditchers
Mole-Drain Machines

Write for Literature

THIS tandem compacting disc is a clod breaker, a smoother, a compacter and a mixer for uniform density of earth in fills, etc. Widths 5′ to 10′. Weights 1100 to 2700 lb. Discs 20″, 22″ or 24″ in diameter. Discs 6″ or 9″ apart. Photo shows the 8′ model on highway fill near Henry, Illinois. Sold by "Caterpillar" distributors everywhere. Write for folder. Killefer Mfg. Corp. Ltd., Los Angeles, California, and Peoria, Illinois.

Road Disc Harrows

Air Compressor *from* FORD PARTS

Model A or B Ford Motor fitted with patented Smith Compressor Head with two cylinders for power and two compressing air. Over 60 cubic feet per minute capacity. Head equipped with high speed compressor valves. Automatic unloading and idling. Widely used to operate jackhammers, paving breakers, clay spades, tampers, riveting hammers, sand blasts, paint sprays, etc.

Low first cost, light weight, economical operation, repair parts available everywhere.

Complete machines available or Smith Compressor Head and accessories with instructions for mounting.

Write for complete information and prices.

GORDON SMITH AND COMPANY, INC.
516—10th St., Bowling Green, Kentucky

SIMPLE RUGGED DEPENDABLE CONSTRUCTION EQUIPMENT STERLING QUALITY

TRASH TYPE IMPELLER

Sterling self-priming pumps are equipped with heavy-duty impellers of highly efficient design, made of wear-resisting, close-grain nickel semi-steel. The impellers are of the wide blade, open trash type and are especially designed to handle large percentages of solids. Write for new Contractors' Catalog No. 37 which tells about the many other superior features of Sterling pumps.

Sterling MACHINERY CORPORATION
411-13 Southwest Blvd. Kansas City, Mo.

FWD Purchases $100,000 Worth of New Production Equipment

Purchase of $100,000 worth of new production equipment by the Four Wheel Drive Auto Co. of Clintonville, Wis., and Kitchener, Ont., Canada, is being undertaken because of a notable increase in the company's sales volume, according to Walter A. Olen, president and general manager.

Issuance of $100,000 in rights to stockholders to purchase a new issue of common stock has provided the company with new working capital. Additional working funds will be obtained after the close of the fiscal year, June 30, through the issuance of more rights, Mr. Olen said.

Expenditure of the $100,000 will provide the company with a new heat-treating department which is now being installed; new lathes, gear-cutting machinery, and other production equipment.

Production of FWD trucks, the company's well known product, must be geared to handle a sharp increase in sales volume, according to Mr. Olen. Orders booked ahead by the company have been holding a level between $800,000 and $1,000,000. Sales since July 1, 1936, have shown a gain of 48 per cent above those of the fiscal year 1935-36.

In the foreign field alone the company has enjoyed a new spurt in its sales activity.

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New Distributor for Hypressure Jenny

The Hypressure Jenny Division of Homestead Valve Manufacturing Co., Coraopolis, Penn., announces the appointment of the following distributors for handling exclusively its line of chemical vapor spray cleaning machines: Toledo Equipment & Supply Co., 1007 Jefferson Ave., Toledo, O.; Oil Burner Equipment Co., 504 Lafayette St., Tampa, Fla.; Merkel & Roberts, 478 E. Erie St., Painesville, O.; Gleasner Corporation, 217 Leroy Ave., Buffalo, N. Y.

▼

Abeles Now With Easton Car

Charles Abeles has recently joined the sales organization of the Easton Car & Construction Co., Easton, Pa. Mr. Abeles is making his headquarters at the New York office of the company. Formerly Mr. Abeles was with the Koppel Industrial Car & Equipment Co. as assistant sales manager in charge of the Eastern district.

▼

Bucyrus Erie Appoints New Distributor

Bucyrus-Erie Co., South Milwaukee, Wis., has appointed James W. Bell, Cedar Rapids, Ia., as its new distributor in that territory. The James W. Bell Co. will cover the majority of the state of Iowa except for the extreme western area and will carry the smaller machines in the Bucyrus-Erie line as well as a stock of repair parts.

▼

W. D. Ball Now District Representative for Tractor & Equipment Co.

W. D. Ball, 600½ West Madison St., Ottawa, Ill., recently has become associated with the Tractor & Equipment Co., 433 South Jefferson St., Chicago, Ill., as district representative in La Salle and adjoining counties.

Tractor & Equipment Co. Holds Annual Show

Attendance at the dirt-moving, road-building and international power show held April 16, 17 and 18 by the Tractor & Equipment Co., distributors, 433 South Jefferson St., Chicago, Ill., was more than double that of last year, and actual sales are stated to have tripled last year's record.

Representatives from the International Harvester Co., J. D. Adams Co., Bucyrus-Erie Co., Bay City Shovels, Inc., and many other equipment companies were always on hand to explain the details of their efficient machinery.

Demonstration of International TracTracTors and tractors, which took place in a block-square field directly across the street from the company's showrooms, was well attended throughout the three days of perfect weather. Many types of road-building, dirt-moving and hoisting equipment were demonstrated throughout the day.

▼

Independent Pneumatic Shows 25% Increase in Business

The Independent Pneumatic Tool Co., 600 West Jackson Blvd., Chicago, Ill., and subsidiaries showed an increase of 25 per cent over 1935, to earn $1,096,271 during the year ending Dec. 31, it was announced by Neil C. Hurley, president. The earnings were larger than any year since 1929 and compare with $879,667.37 in 1935. The net income amounted to $5.83 per share, as against $4.68 per share in the preceding year. Mr. Hurley, in his report to the stockholders, expressed confidence in the current trend of business, stating that all indications pointed to further increases this year both in volume and profits. The increase in the Universal Electric Tool Jobbers' Department and the additional products contributed largely to the 1936 increase, Mr. Hurley declared.

▼

Lincoln Increases Sales Staff of Philadelphia Office

Announcement has been received from the Lincoln Electric Co., Cleveland, O., of two appointments to the sales staff of its Philadelphia office, 401 North Broad St. The new appointments include William Sivyer, graduate of the University of Illinois, and B. B. Ross, graduate of Kentucky Wesleyan College. Mr. Sivyer and Mr. Ross will assist Messrs. O. P. Lang, H. H. Stahl, L. J. Cogan of the Philadelphia office, which is under the management of George R. Johnson.

▼

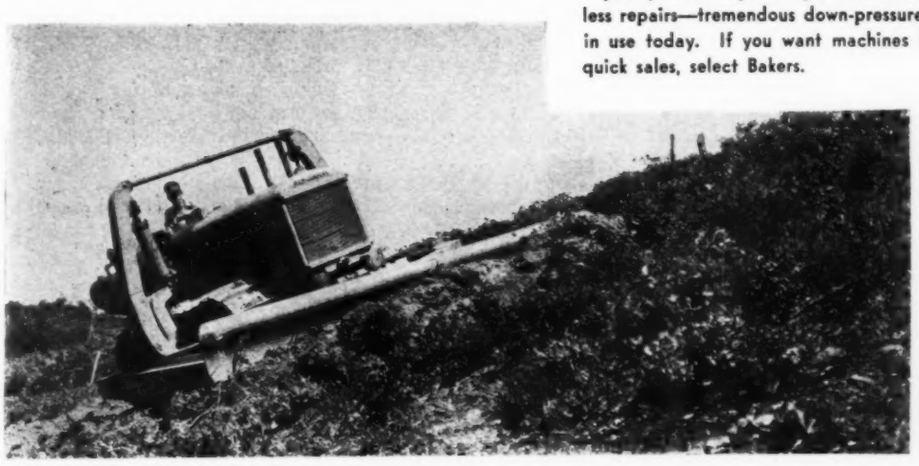
Montreal Distributor, Bucyrus-Erie, Changes Address

The Bucyrus-Erie Co., South Milwaukee, Wis., announces the change of address of the F. H. Hopkins Co., Ltd., distributor, to 340 Canada Cement Bldg., Phillips Square, Montreal, Que., Canada. This firm was formerly located in the Dominion Square Bldg., Montreal.

BAKER

Judge Them By Their Work

You are asked to judge Baker Direct Lift Bulldozers and Gradebuilders by their performance, not only by our claims. Such features as larger capacity—fewer parts—greater strength—more accurate control—less repairs—tremendous down-pressure, account for the large number in use today. If you want machines built for real work and not for quick sales, select Bakers.



Ask for 32-page Bulldozer Bulletin and other Baker literature.

BAKER TRACTOR EQUIPMENT
BULLDOZERS
GRADEBUILDERS
ROAD ROOTERS
TRACTOR SCRAPERS
ROAD DISCS
MAINTAINERS
SNOW PLOWS

Above, a Baker Gradebuilder on Sky Line Drive in Virginia — M. E. Gillioz, Contractor, Monett, Mo.

GRADEBUILDERS
BULLDOZERS

THE BAKER MFG. CO.
506 Stanford Avenue
Springfield, Illinois

FIRST

1923 Insley built and introduced the FIRST ⅜-yard shovel. Because it was mobile, fast, economical to run and smooth in its operation—it proved a money-maker for the contractor.

1937 The Improved Type K-10 Insley Excavator is still the first choice of shrewd contractors, because it gives the maximum in profitable shovel performance with still lower operating and maintenance costs.

A NEW BULLETIN JUST ISSUED GIVES THE FACTS... ASK FOR IT TODAY

INSLEY MANUFACTURING CORP., Indianapolis, Ind.

INSLEY SHOVELS

RIGHTLY PRICED . . . SOUNDLY ENGINEERED . . . NATIONALLY SERVICED

Yes—We would like you to mention ROADS AND STREETS

ADVERTISING PAGES REMOVED

Bigger Home for H. S. Watson Co.

Continued sales growth has again caused the H. S. Watson Co. to increase its headquarters office accommodations. The company now occupies an entire building at 1145 Harrison St., San Francisco.

The popularity of Watson-Brown-Lipe auxiliary transmission among operators of dump and mixer trucks has increased steadily since they were introduced to the automotive world, less than three years ago, according to the company's president, Howard S. Watson.

New Home of H. S. Watson Co. Insert, H. S. Watson

A nationwide distributor arrangement has been established for quick delivery of these auxiliaries to all truck dealers, fleet operators, trailer builders and truck equipment supply stores. These outlets receive direct factory shipments from the Toledo factory of the Spicer Manufacturing Co., where the Watson auxiliaries are produced.

▼

Heil Co. Carrying Out Plant Expansion Program

Julius P. Heil, president of the Heil Co., Milwaukee, Wis., announces an extensive plant expansion program. Ground has been broken for the construction of an addition to the Heil factory which will add 75,000 sq. ft. of floor space to the present 400,000 sq. ft. now occupied by the Heil Milwaukee plant. The extension was necessitated by increased business in all departments, but especially in the road machinery division.

The new addition will be of steel sash and brick construction and will be serviced by overhead cranes. One section of the building is to be two stories high to permit fabrication of pasteurizing equipment and large storage tanks, which are among the many products manufactured by the company. The entire structure will be in the form of a "T" adjoining the present building. It is expected to be completed ready for manufacturing operations by June 1, and will greatly speed up production, enabling the firm to take care of rapidly increasing business.

Building of the new addition marks the fourth major expansion program in the history of the Heil Co., which was started by Julius P. Heil as the Heil Rail Joint Welding Co. in 1901. In 1908 larger quarters were built. Business continued to grow, and twice in subsequent years the firm was compelled to increase its facilities.

The Heil Co. manufactures hydraulic hoists and bodies for trucks, steel tanks, bottle washers, truck tanks, dehydrating machines, trailbuilders and scrapers, water systems, steel tanks, oil burners and snow plows.

The Heil Co. also operates a plant at Hillsdale, N. J., as well as direct factory branches in principal cities.

▼

NEW LITERATURE

Hard Surfacing Road Equipment—Realizing that many welders serving in shops and camps of National forests, highway departments and road contractors have not had much experience in the application of hard metals, the Stoody Co., Whittier, Calif., has brought out a 60-page book illustrating and describing the application of its products to road building and maintenance equipment. The book contains a chapter on hard surfacing procedure, and then illustrates and describes the method of applying hard facing to various kinds of equipment such as power shovels, tractors, graders, crushers, small tools, etc., etc.

Bituminous Distributors—A new bulletin on its bituminous distributors has just been issued by the Austin Western Road Machinery Co., Aurora, Ill. Outstanding features of the distributors are illustrated and described. Copies are available from the company.

Bridges, Buildings, etc.—A well illustrated 12-page bulletin (No. 602), picturing a few of the company's many and varied construction activities, has just been issued by the Pittsburgh-Des Moines Steel Co., 3456 Neville Island, Pittsburgh, Pa. This interesting new bulletin pictures and describes such construction projects as bridges, buildings and steel structures of all kinds, pipe lines, station piping, equipment installations, water treating plants, irrigation systems, penstocks, swimming pools, refuse incinerators and sewage disposal plants. Copies are available by addressing the Pittsburgh-Des Moines Steel Company.

Four Rear Wheel Drive for Trucks—Descriptive literature on the Thornton four rear wheel drive for trucks has been issued by the Thornton Tandem Co., 5124 Braden St., Detroit, Mich. Separate circulars for the use of the drive with Ford and Chevrolet truck chassis are available. Installation views are given as well as performance data in term of road speeds, gear ratios, rim pull and grade ability. Copies are available from the company.

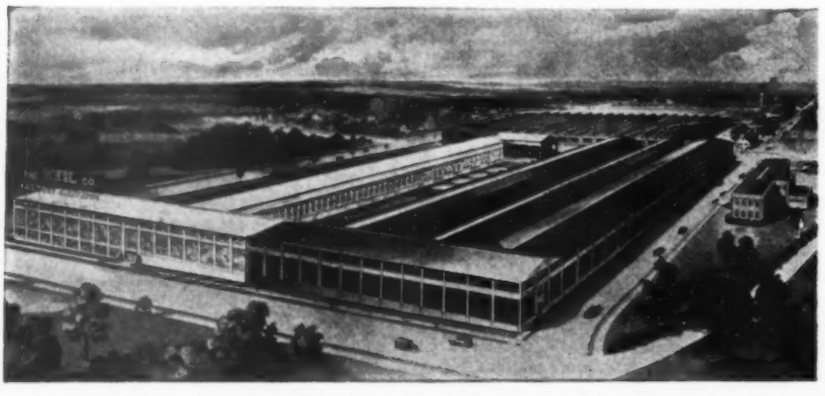
Construction Equipment—A most interesting catalog on its line of equipment for road builders and contractors has been issued by the Jaeger Machine Co., 223 Dublin Ave., Columbus, O. It is not only a description of machines but also an illustration of construction methods. Various types of equipment are illustrated and described and their applications on many jobs are shown. Write the Jaeger Machine Co. for your copy.

Dump Bodies and Hoists—A new 36-page catalog of its dump bodies and hoists and steel express bodies has been issued by Anthony Co., Inc., Streator, Ill. It covers four complete lines of dump bodies and a complete line of steel express bodies and includes a total of about 24 different hydraulic hoist models, all made by the company, including cylinders, pumps and complete hydraulic mechanism.

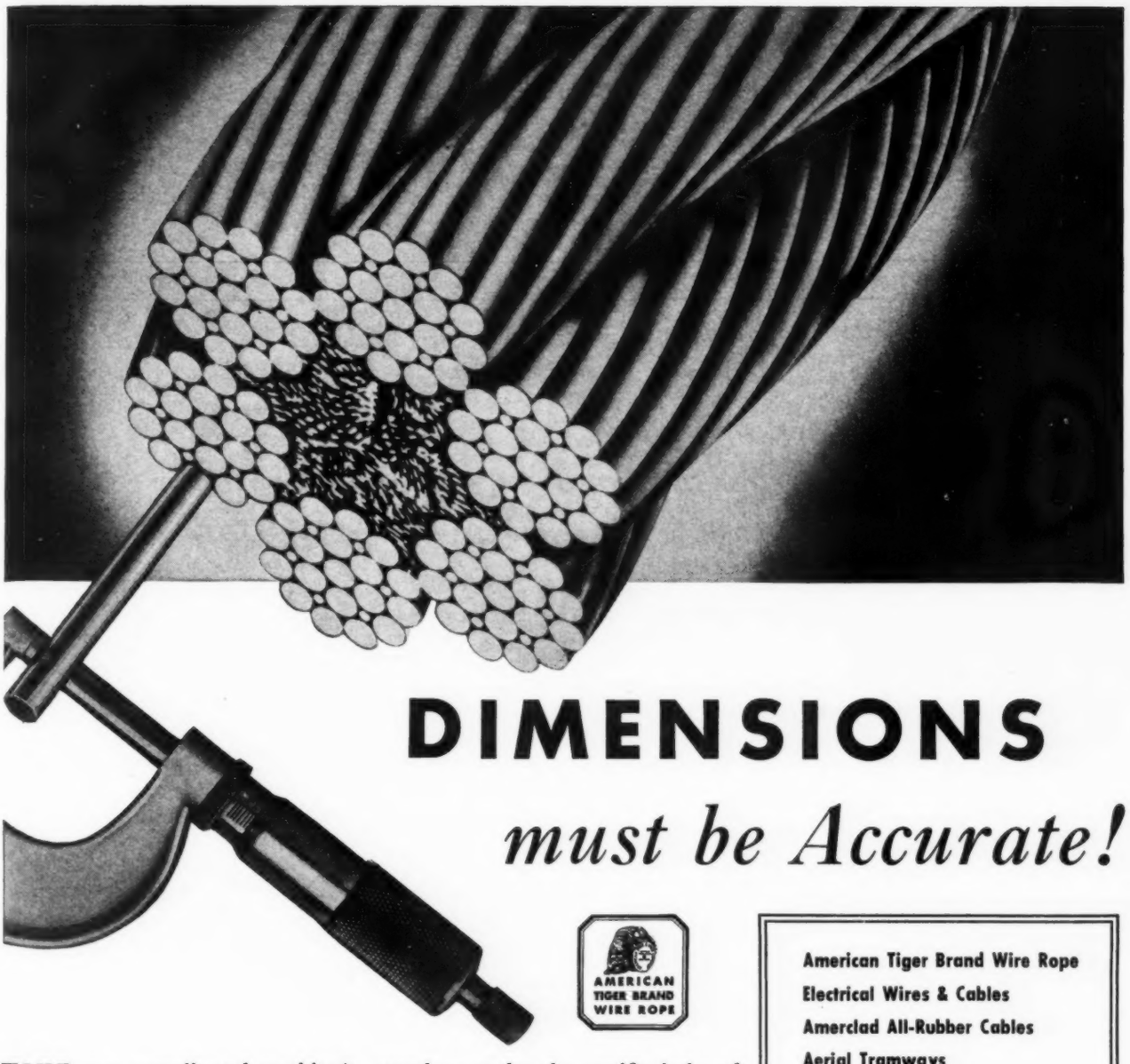
Salt Stabilized Roads—The Morton Salt Co., Chicago, Ill., and Hutchinson, Kan., has issued its latest recommended specifications for salt stabilized roads. The specifications are dated April 12 and suersede the previous issue of June 22, 1936. Copies of specifications, construction manual and booklet on salt stabilized base courses for bituminous surfacing can be obtained by addressing either of the above offices.

Locomotive Cranes—An excellent gotten up, well illustrated catalog on "American" gasoline and diesel operated locomotive cranes has been published by the American Hoist & Derrick Co., St. Paul, Minn. It contains numerous illustrations in colors of the "American" at work on various jobs. General specifications for the cranes are given.

Crushers—The Iowa Manufacturing Co., Cedar Rapids, Ia., has just issued a new catalog on its "Cedar Rapids" roller bearing crushers. Contains descriptions and numerous illustrations of the crushers together with specifications.



View of the Heil Co. Main Works and General Offices, Milwaukee, Wis. The Light-Toned Buildings to the Left Show the New Addition Now Under Construction



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WRITE for our new circular showing illustration and description of Olsen Special Bench Type Compression Testing Machine. It is designed especially for testing 2" x 4" cylinders and 2" x 2" cubes. The machine is hydraulic, having two gauges, one to half and the other to full capacity. Capacity ranges of from 20,000 to 80,000 lbs.

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